Preservation of Fruit
and
Vegetable Products

By
R.P. SRIVASTAVA

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CONTENTS

CHAPTER Page

1 History of food preservation and canning industry ... 1

2 Scope of fruit and vegetable preservation in India. ... 6

3 Spoilage in preserved foods and its prevention ... 12

4 Unfermented fruit beverages.
Fruit juices, Squashes, Syrups, Cordials, Lemon barley water, Flavoured Drinks, Carbonated fruit beverages. ... 32

5 Fermented fruit beverages.
Wine, Cider, Perry, Orange wine, Berry wine, Champagne, Muscat, Port Sherry, Tokey ... 47

6 Vinegar. ... 51

7 Jam, Jellies and Marmalades. ... 57

8 Fruit Preserves (Morabba and Candy). ... 66

9 Canning and Bottling of fruits and vegetables ... 72

10 Drying and Dehydration of fruits and vegetables ... 90

11 Pickles and Chutneys. ... 96

12 Products prepared from different fruits.
Apple, Banana, Bel, Cashew apple, Citrus, Guava, Grapes, Jackfruit, Litchi, Loquat, Mango, Papaya, Pineapple, Sapota, Tomato. ... 103

13 Fruit by-products. ... 130

14 Names of spices commonly used, some important data, some useful notes and names of Indian fruits. ... 132

15 Essential apparatus and equipments. ... 136

INDEX ... 139

PREFACE TO THE SECOND EDITION

This book was first published in 1962 and became out of print within the same year due to great demand. During my graduate level studies in Horticulture with Fruit Technology, I found this book to be most informative under Indian conditions. In nut shell it deals with the preservation of all important fruits and vegetables. I pressed my father (Dr. R.P. Srivastava) to revise it but he could not do so due to his busy engagements and he assigned this work to me. However, he was kind enough to go through the revised manuscript critically before passing on to the press.

There may be still some shortcomings in this book and I shall be really thankful to receive the criticisms that the readers would like to make in order to effect further improvement in the next edition.

S. Rajan

Pantnagar (Nainital)
May, 1982

PREFACE

The need of a book on fruit and vegetable preservation has been keenly felt by the students of Agriculture. This book is an attempt to meet that need of Agricultural students having Horticulture as one of their main subjects. It deals with the products prepared from Indian fruits and vegetables, a part of the horticultural science. The present volume has been prepared primarily with a view to prove useful to the students of Horticulture, Fruit Technology, Home Science and a guide for home scale preservation for public men as well. For the latter, matter of direct practical value has been presented. Most of the data in this volume have been collected from reliable Indian and foreign literature.

The author acknowledges his indebtedness to the kind suggestion and encouragement afforded by Dr. J.R. Singh, Head of the Horticulture Section, College of Agriculture, Banaras Hindu University.

The author is grateful to Dr. S.P. Mukharji, Mr. M.L. Gupta, Dr. B.D. Pandey, his colleagues, friends and students for their sincere encouragement during the preparation of this volume.

The author wants to express his deep sense of gratitude to Dr. V.M. Mandokhot and Dr. G.S. Bhandari for their time to time suggestions and pains taken in reading the proof and helping at every stage of preparation of this volume in the form it is being presented.

The author believes that the readers will get sufficient information connected with the preparation and preservation of Indian fruit and vegetable products. There may, however, be still some shortcomings in this book and the author will be really grateful to receive the criticisms that readers would like to make in order to effect further improvement in presenting the next edition of this volume.

Varanasi (India) R.P. Srivastava
June, 1962.

CHAPTER 1

HISTORY OF FOOD PRESERVATION AND CANNING INDUSTRY

The art of preserving fruits and vegetables has been in practice from time immemorial and in modern times it has become a specialized branch of food technology. In ancient times pickling with the help of salting, and drying of fruits and vegetables by the aid of sun heat were common methods of preservation.

Needham concluded by putting some boiled mutton gravy in a tightly corked vessel that the life of some organisms develops spontaneously. He published his results in 1749. In 1765, Spallanzani, an Italian naturalist challenged the results of Needham and after careful experiments he concluded that untread air in some organisms manner causes spoilage and by heating thecontents in airtight vessels the spoilage could be prevented.

The canning industry was actually conceived in the time of war when in France, Napoleon's Army men were in great difficulty to get food materials. In the year 1795 a prize of 12,000 francs was announced to be offered to the man who could preserve food materials for a longer period. Ultimately the prize was won by Nicholas Appert who started his work from 1795 and in 1804 he succeeded in preserving food in glass containers. He won the prize in the year 1809 and published a book on food preservation in 1810, the English translation of which was entitled as "The Art of preserving all kinds of animal and vegetable substances for several years." In his book Appert discussed four important points as mentioned below :

(1) In enclosing the bottles the substances to be preserved; (2) In corking the bottles with utmost care on which the success of process depends; (3) In submitting the enclosed substances to the action of boiling water for suitable duration with respect to different substances; (4) In withdrawing the bottles from water bath at the end of the prescribed period.

It is clear from the above points that Appert concluded all the important principles which are followed at present in every cannery. The methods originated by Appert gained a wide popularity and in 1819 it was introduced by Englishmen in America at Boston and New York.

As mentioned above Appert originally used water bath for sterilizing glass jars but other workers following his principles started to raise the temperature by adding common salt or calcium chloride for shortening the time required for sterilization.

Later on, Louis Pasteurin a chemist and bacteriologist demonstrated the role of organisms in food spoilage and spread of certain diseases. He also studied and demonstrated the real causes of food spoilage. The term "Pasteurization" has been coined to honour Pasteur.

Cooking of foods by means of pressure was first attempted by Papin in 1861 and it has also been reported that processing of canned foods by steam and water under pressure was used by Winslow and Raymond Chevalier Appert in the year 1843. These pressure vessels were defective and resulted in frequent explosions.

Autoclave, which was provided with steam inlet from outer source was used by Shriver in 1874 and the use of pressure vessels to process canned foods received a great encouragement for the advancement of canning because it requires less time in the processing of the can and its content and permits a wider range of packs to be kept for the purpose.

In modern days after proper findings it is always tried to improve the quality of products and a shorter processing time with higher temperatures. H.T.S.T. Process has been proved to be a better solution for many of the liquid products such as fruits, juices, milk and products and squashes.

History of sanitary or open top cans

Soon after Appert received the award, Augustus de' Heine was granted patent in the year 1810 for using iron containers and in the same year Peter Durand was also granted the patent to use metalic containers for preserving food. Donkin and Hall's canning factory started in the same days and the filled cans were tested by placing them in closed chamber and a heat of 90-110°F was given. Defective cans were detected by the bulging of their ends.

In early days the name "tinplate canister" was popular. It was later shortened to "tin cans" or tins in England and "cans" in America. These cans were very crude in show and construction as compared to the modern open top sanitary cans. They were made entirely by hand with a heavy tin coating. Hand shear was used to cut the round ends and blanks for bodies. The body blanks were bent round a roller and the overlapping edges being sholdered to form the side seam. The round end discs were cut slightly larger and the remaining edges were turned over forming a flange fitting tightly over the body by hammering the disc of the plate over a stake. A hole was made in one of the ends and finally after filling it was closed by sholdering on a small tin plate disc and this type of cans were known as "hole-and-cap" can. These cans were in use as early as 1824 but it was disclosed after 15 years when a patent was granted to Fastier in 1839.

Angilbert in 1833 tried to re-use the containers in which a full aperture could be used for filling, but his method of closing was very cumbersome. However, his method and attempt was quite similar to the present system which has been adopted for ordinary type of can.

In 1847 a drop press machine was invented in America and upto that time hand making of the cans continued. By this machine flanged ends were produced from flat discs by dropping a heavy die on to the blank. After this pendullum press was invented which was followed by combination press which used to cut the discs, flange them and punch the filter holes.

Due to the above advancement more rapid production of bodies started by various mechanical aids. In 1876 a method of sholdering by sholder float was invented by Howe in which the quantity of sholder as well as time both were minimised. In this method the seams were sholdered by rolling the cans at an angle and dipping them in moulten sholder.

The 'filter hole' cans remained for a very longer time and it was very difficult to open them as one was compelled to cut them with a 'hammer and chisel'. On the other hand while filling, only products of very small sizes could by inserted in it due to limited size of hole and there was a great loss to products of large sizes. Having these things in view advancement of the cans was obvious and ultimately the "open top" cans were invented.

In the year 1900 Ams brothers were the first producers of prototype cans which are also called "open type" or "sanitary" can and exist in these days as well. They succeeded in this sphere as they used a compound for lining the can ends to produce a hermetic seal to overcome the irregularities due to the variation in thickness of the plates.

The lacquering of cans also plays a great role for minimising the effect of corrosion and protect the can contents from metallic contamination. In the year 1868 Peltier and Paillard of Paris used varnish for internal coating but in 1882 Parry and

Cobley suggested to coat cans with sodium or potassium silicates, calcium silicate and a serum made of protein containing materials.

The use of lacquer received greater attention when highly coloured products became bleached or faded their colour in plain tinplate cans. Blackening of cans and its contents were also the main evils of plain ones which were afterwards prevented by lacquers. However, the use of the lacquers suitable for coating is not an easy matter as it must be non-toxic, odourless and unaffected by food stuffs preserved in the can without destroying the flavour of the products, on the other hand it must properly adhere to the cans with toughness and may not be affected by the wide range of temperatures during processing.

In the year 1941, Farrow and Green suggested the 5 group of lacquers :

1. Acid-resisting clear lacquers,
2. Sulphur-resistant lacquers,
3. Double-coated meat lacquers,
4. Phenolic meat lacquers, and
5. Lacquers for deep drawing.

Recently a lacquer has been introduced for canning of corrs and known as "corn enamel". It is a sulphur-resistant lacquer and can be classified under no. 2.

CHAPTER 2

SCOPE OF FRUIT AND VEGETABLE PRESERVATION IN INDIA

Storage of food material in perfect consumable condition for a longer time without undergoing any spoilage is the main object of fruit and vegetable preservation. A variety of products such as jam, jellies, marmalades, squashes, chutney, pickles, vinegars and many other products described later can be prepared from fruits and vegetables.

In addition to their immense food value, fruits and vegetables constitute appreciable quantities of minerals and vitamins which are main source of nourishment and body building. Fortunately, India is an ideal country in the sense that nearly all the important fruits and vegetables can be produced with ease due to varied soil and climatic conditions. But many of the fruits and vegetables which are quite cheap in the season are wasted to an extent of crores of rupees annually. This wastage can be minimised and these products can be consumed by a common man in off-seasons as well. There are certain periods of glut when raw materials are available in plenty and they do not fetch a good price in the market. While in other seasons they are not available at any price. As for example, tomato is cheaper in the season selling about 25 paise a kg. Therefore, these food materials of immense economic and nutritive value must not be wasted and should be preserved when are cheapest in the market.

In spite of the great economic importance and wide scope, this branch of Food Technology has not received the impetus it deserves. Therefore, if it is to be developed in proper perspective and the following problems are to be dealt with in a right easiest way.

1. Availability of raw material,
2. Labour problem,
3. Capital,
4. Lack of interest and scientific knowledge,
5. Marketing facilities,
6. Transport facilities,
7. Availabiliy of cans and bottles,
8. Publicity of the products and
9. Role of the Government.

1. India produces all sorts of vegetables and fruits in abundance. Some fruits like mango, guava, sapota, banana, cashew nut, jamun, pineapple, aonla, jack fruit are not available in every country and their products specially of mango have a great place in the foreign market. These fruits are available in plenty at a quite reasonable rate in the season and a major portion of them is destroyed un-utilised. Hence if they are preserved, they fetch a very good price in the off seasons and if exported, it would be a good source of foreign exchange. For maintaining the standard and quality of the products, raw material used should be of a very high merit, i.e., properly ripened, free from diseases, bruises and other defects.

2. The problem of labour is not so acute in India but the labourers are very poor, lethargic and slow workers when compared with other countries. So they require proper training, domestic facilities and considerate wages, which is too low in certain parts of the country. Low payment is also one of the main causes that they work proportionately according to the amount they get.

3. Capial is the main thing which is to be considered before starting any industry. India is a poor and somewhat backward country in this field, but still there are several capitalists who rank themselves in the whole world considering their wealth and can start several preservation factories. In recent years a number of preservation factories have sprung up and are functioning in the country due to the initiative and finance of these business magnets but the number is still too low and requires more extension.

4. Most of the extensive growers of fruits and vegetables have no idea of preservation. Some of them who are interested are lacking in the scientific knowledge. The Government has started a number of projects to train the private personnel on scientific and easier lines to give proper information regarding machines etc., and to can and preserve the food materials which are not easily possible in a common Indian home. The details regarding the initiative of Government have been dealt in the last.

5. For any produce marketing must be of a perfect order so that the producer may get reasonable return. In India there is a good demand of preserved products but they are not available in every market. This is only due to defective marketing system and lack of interest in the shop-keepers for storing fancy materials. For this there must be cooperative organisations to help in marketing about which the Government is quite particular and such systems are being enforced.

6. Previously it was a problem in India to get any fruit or vegetable from other parts of the country and is anyhow they were received their condition was of third rate quality. It was due to less number of roads and defective transport system. Now the transport system is very much advanced and any cannery or preservation factory can get raw materials in

perfect order from any part of the country by trains and by truck through transport agencies. The roads are also towards advancement and the days are not so far off when anything can be purchased from a small market, only due to this facility. By better transport facilities the raw materials as well as processed ones will be received in safe condition and on the other hand the cost will also decrease due to less spoilage and theft in the transit.

7. Cans and bottles are the main containers used in preservation factories. Previously all the cans and bottles were imported from other countries and it was not possible to get these containers in desired numbers. Now the manufacture of bottles is being taken up by a number of factories all over the country and they are preparing bottles of desired standard.

At present there is a great difficulty due to the shortage of cans and there are a very few factories which are dealing with the manufacture of cans. Metal Box Company of India, Calcutta, is the premier concern of the country in this field with its branches at Delhi, Bombay, Mangalore and Madras. For proper supply of cans there must be a good number of factories in the country so that the canning process may not suffer due to the shortage of cans.

8. Publicity in the proper way is the main item which attracts the eyes of a consumer and gives him a knowledge about the new additions to the markets. So the publicity of the preserved materials by practical demonstrations may capture good market even in less developed areas as a major population is not in the know of these products. These things can also be popularised by placing in small exhibitions and fairs by practical demonstrations and distributing the samples in the public.

9. The Union Government as well as all the State Governments are giving preference to fruit and vegetable

preservation. In Uttar Pradesh a separate Directorate of Fruit Utilization was established which is playing a great role in the advancement of this branch. The remarkable functions of the department are as follows:

A. Community canning centres,
B. Training courses,
C. Research,
D. Commercial canning and Preservation factories.

A. Community canning centres have been established at every divisional headquarter in Uttar Pradesh and now in every important district and production centres. It is hoped that such centres will start functioning very soon at other important places. The function of these centres is to give technical advice to the public and to get the raw materials properly canned or processed by the aid of latest machines which is not possible for a private individual to do at home even having a good knowledge of the subject.

B. Many types of training courses are in progress. At every divisional headquarter and in important community canning centres there is a team of Instructors, who give short course training in Fruit Preservation. At some places a separate batch for ladies, consisting of one *lady* Instructoress, one or two Assistant Instructoress and two attendants mostly ladies, have also been deputed considering the demands. This batch can also go to the places in any part of the State where the whole batch of trainees is of ladies. This duration is of about 3 weeks in which practical as well as theoretical training is given for preparing products used daily for home consumption.

Some extensive trainings are also given which are of 3 and 6 months duration in which a sufficiently good knowledge is given both in theory and practice connected with fruit and vegetable preservation.

A Post-graduate Diploma training course of 15 months duration which was started in 1960 is one of the important features of the department which run at Govt. Fruit Preservation and Canning Institute, Lucknow. The trainees of this course are also given **3** months factory training at the end and when they come out after completing this course they are competent enough to explain and demonstrate properly in the general public in simple language. After the partition same type of training is also given at Indian Food Technological Research Institute, Mysore. Previously it was at Lyallpur (Pakistan) and was known as Fruit Products Laboratories, Lyallpur and was under the control of Indian Council of Agricultural Research.

Opening of Horticulture departments in the Agricultural Institutions with Fruit Technology as a major subject will also help the students of Horticulture for the advancement of this branch of Agricultural Science. Some of the Agricultural universities have taken up the work on speciliased lines.

C. There are many research workers who are engaged in U.P., Delhi, Ludhiana, Calcutta and Central Food Technological Research Institute, Mysore. Experiments are being conducted to introduce better and new methods for the preservation of fruits and vegetables under Indian conditions. The Government is giving every type of facilities to all the laboratories in which this type of work is going on.

D. The Government has established food preservation and canning factories where canning of fruit and vegetable products is done on scientific and commercial lines. The Government charges fixed prices for the products and they are sold at reasonable and cheaper rates for popularising in the public. These products are refreshing, pleasing, nutritive, fine in taste and nice in appearance.

The development of Fruit and Vegetable Preservation industry, on above lines may afford a bright future scope in India.

CHAPTER 3

SPOILAGE IN PRESERVED FOOD AND ITS PREVENTION

Any preserved fruit or vegetable product can be classified as spoiled when for any reason the product has deteriorated during storage. So it is essential for the workers dealing with the subject to be acquainted with its causes. Spoilage is brought about by the activity of micro-organisms, physical and the factors, faulty technique, rough handling, poor storage etc.

The main causes of spoilage of canned and other preserved products can be classified as under:

A—Chemical and Physical spoilage

(i) Swells
(ii) Overfilling
(iii) Faulty retort operation
(iv) Under-exhausting
(v) Panelling
(vi) Rust
(vii) Damage
(viii) Foreign flavours
(ix) Discolouration of the can or its products
(x) Undesirable textures
(xi) Corrosion of the can

B—Microbiological spoilage

(i) Pre-process spoilage
(ii) Under-processing
(iii) Infection due to
  (a) Leakage through seams
  (b) Buckling
  (c) Leakers and
  (d) Flat sour

C—Enzymatic spoilage

A—CHEMICAL AND PHYSICAL SPOILAGE

(i) Swells

Generally the ends of a normal and perfect can with a good vacuum are flat or slightly concave. A can which bulges its ends by the positive internal pressure due to gas formed by microbial or chemical activity is termed as "Swell" or "Blower".

Hydrogen swell. This is caused due to the formation of hydrogen and is followed by internal corrosion of the can. The swells or bulgings range from 'flipping' to the 'hard swell'. The products of such cans are usually harmless for consumption and it is due to the foods containing organic acids such as fruits and other acid products which corrode the interior of the cans.

Flipper. In the initial stages of the swell the can looks normal, but when it is struck against a solid or table top it becomes convex and springs or flips out, but it can be pushed back to its normal condition by a little pressure. A can in this condition is technically termed as "flipper". It may also be caused due to overfilling, faulty exhausting or gas pressure due to spoilage.

Springer. In the advanced stages of swell one end of the can becomes bulged and on pressing or pushing the other end bulges in the place of previous one and a can in this condition is known as a "springer".

Soft swell. In still advanced stages the swells develop on the both ends of the can and they can be pressed and may be returned to normal condition, but they come to their own shape or spring back when the pressure is released. A swell of this type is termed as "soft swell".

Hard swell. This type of swell is quite different and the can becomes in such a condition that the bulged portions cannot be pushed to normal condition and this type of cans ultimately burst. This is the final stage of swells.

(ii) **Over-Filling**

This type of spoilage is found generally in canned products. During retorting the overfilled cans become strained due to the expansion of the contents on the other hand the absence of vacuum in such cases cause swelling of the can. If the cans are properly heat exhausted the excess material will overflow due to expansion and thus spoilage due to overfilling can be avoided.

(iii) Faulty Retort Operation

When the steam pressure is reduced rapidly at the end of processing it causes high pressure inside the cans and ultimately results such distoration and straining that the eans when cooled look like "Swells". Very thin tin plates must not be used as they cannot withstand the pressure set up in the cans while processing and ultimately cause straining.

(iv) Under-Exhausting

Improperly exhausted cans may suffer severe strain due to excessive internal pressure during heat processing by the gas present in the can. The under-exhausted cans appear from slight flipping to distoration which depends upon the residual gas evolved from the products and the size of the head space. All the gas must be removed by tilting the can and pressing its ends.

(v) Panelling

This type of spoilage is generally noticed in large sized cans due to a great vacuum, and the body of the cans is pushed in due to atmospheric pressure. This is also caused when the tin plate is thin or the cans are pressure cooled where the air pressure is excessively high. In very severe cases it may result in seam leakage but normally it is not regarded as a spoilage.

(vi) Rust

The cans having external rust must be thoroughly examined. If after removing the rust, the walls give pitted appearance, such cans should be classified under spoiled ones. Cans affected slightly without noticeable rust should be sold or consumed immediately. Rust formation is mostly seen under labels due to hygroscopic substances which subsequently stain the labels as well. The spoilage due to rust formation may be checked if the cans are externally lacquered and be stored for a longer period.

(vii) **Damage**

Rough handling also causes spoilage to the cans due to damage which is the result of carelessness or ignorance. If the cans show any signs of leakage or severe distoration they must be rejected.

(viii) **Foreign Flavours**

While in storage, preparation and filling or even in transport the conditions become unhygienic and the products develop foreign or "off-flavours" which promote the microbial action. If unsuitable metallic containers are used, they cause "metallic flavour". The flavour is one of the main characteristics which should be maintained and the packs must be examined at proper intervals for maintaining the same.

(ix) **Discolouration**

This factor is directly related with the appearance of the can and its products and it is detected by the consumer even if he is not a technical man. Sometimes hydrogen sulphide gas is liberated from the canned products which contain proteins. This can be entirely checked if suitable lacquers for coating the interiors of the cans are used. Discolouration is also caused by unsuitable vessels as even traces of copper (1 ppm) may cause blackening of the products. Water containing dissolved minerals also affects the contents and deposits of calcium oxalate can be seen in the products.

Discolouration also occurs while over-processing without proper cooling of the contents. This is known as "Stack burning" and it may be easily prevented if properly cooled.

(x) Undesirable Textures

Texture is also one of the important aspects and this should be maintained. Just like flavour and colour it is also detected easily by the consumer if there is any departure from the standard. As in flavour periodical testing of the texture should also be undertaken. Although there are no precise units for measuring the texture but some instruments like "tenderometer" which indicate the resistance to shearing and relative tenderness can be used for peas and beans.

Calcium salts present in water used in canning produce a "toughening effect" to peas and beans, but this type of hardening proves to be useful while canning potatoes and tomatoes.

Processing is also very important so that the soft fruits may not result in the production of pulp due to over-processing.

(xi) Corrosion of the Can

The cans are corroded or perforated due to the acidity of products specially fruits having more acids cause a great damage and loss to canning industry. In recent years progress has been made to check this spoilage of tin plates by using new lacquers for internal coating of cans and development of new chemicals for protecting the contents from corrosion.

B—MICROBIOLOGICAL SPOILAGE

(i) Pre-Process Spoilage

This type of spoilage particularly occurs due to faulty technique. It is generally noticed during warm weather when micro-organisms go on multiplying if there is any delay in filling the container and heat processing. Processing may sterilize and check the growth of the organisms but the gas present in the can causes swelling and flipping. So the delay between filling and processing must be avoided and particularly at all stages in preparation of raw material for canning.

(ii) Under-Processing

Any pack which is spoiled due to the presence of micro-organisms even after processing may be termed as "under-processed". But in some cases contents may also be affected due to the errors in machines. As a general rule the presence of a single species of organism is indicative for under-processing.

It is noticed that even without generation of gas the contents of a can may be spoiled due to production of acids and micro-biological activities. It is known as "flat sour". Spoilage which is mostly resulted due to under-processing, so the contents which may be affected by flat sour organism must be properly processed.

(iii) Infection due to :

(a) **Leakage through Seams.** After processing a considerable number of cans show the signs of spoilage due to leakage of can seams and there is a lot of wastage due to it. The canned products which are the result of post-process leakage may be found attacekd by varying types of micro-organisms. It is mainly found in the cans which are water cooled when compared with the air cooled ones. In such cases the cans may or may not swell which depends upon the type of organism and if there is a defect in the seam it permits free passage of the gas formed in the can. For minimising this type of spoilage the bacterial level of can-cooling water should be maintained at a low level, and the cans should be properly exhausted, thereby minimising seam strain.

(b) **Buckling.** Sometimes due to improper cooling the cans are distorated and these cans resemble to 'Swells'. Although the cans can be returned to normal position by pressing but they are often badly strained and the products become spoiled due to micro-organisms through the strained seams. This type of spoilage is known as "buckling". Sometimes this type of distoration forms a peak or small ridge on the can and is known as "peaking".

(c) **Leakers.** When a can leaks any part of its contents, it is classified as a "leaker". This type of spoilage is caused due to the following reasons.

1. Faulty seaming, 2. Nail holes caused by faulty nailing of cases while packing, 3. Excessive internal pressure due to microbial spoilage or corrosion, which is sufficient to burst the can, 4. Internal or external corrosion and 5. Mechanical damage during handling.

The micro-organisms which are generally responsible for the spoilage of preserved foods are present everywhere in soil, water, air and even in the raw and processed materials. These organisms are broadly divided into three groups :

1. Bacteria, 2. Moulds and 3. Yeasts.

1. Bacteria

Bacteria are the most harmful of all the micro-organisms. These are microscopic organisms and are found in large numbers. Slight acidic and nitrogenous foods are best for their growth and multiplication. It is also very difficult to kill them as they are too resistant to different operations. Some bacteria are so dangerous as they cause food poisoning.

Bacteria are unicellular in structure. The cells are of many shapes, the three main forms being spherical, cylindrical or rod like and spiral. The multiplication takes place by division of cells or "fission". When one bacterium becomes mature it divides into two, these two to four and so on. The growth of bacteria is very rapid and depends upon nature of food material, moisture, temperature and air. Some of them do not favour air but temperature plays a main role for promoting their growth and they generally grow more at human temperature. Low temperatures are not favourable for their growth and when the temperature rises they also start multiplication and growth.

Some of bacteria produce spores and these spores cannot be destroyed without application of strong and continuous heat for 30-40 minutes at a temperature of 212-250°F. Bacteria are very sensitive to acids and can be destroyed in presence of it even at a temperature of boiling water. That is why most of the fruits are easily sterilized at 212°F due to their acid contents and vegetables at 240°F being non-acidic.

Definition of some of the important groups of bacteria is as under:

1. **Bacillus:** a rod shaped bacteria cell.
2. **Coccus:** a spherical bacteria cell.
3. **Coccobacillus:** an oval shaped bacteria cell.
4. **Aerobe-micro-organism:** requiring atmospheric oxygen for growth, e.g., Bacterium aceti.
5. **Facultative anaerobe:** grows with or without atmospheric oxygen.
6. **Obligate anaerobe:** those which do not grow in atmospheric oxygen.
7. **Mesophile :** micro-organism requiring a temperature below 100°F for its growth.
8. **Obligate thermophile:** organism requiring 100-180°F temperature for its growth.
9. **Facultative thermophile:** it grows lower and over the whole range of temperatures covered by mesophiles and obligate thermophiles, e.g., Lactobacilli.

The following bacteria are of great economic importance in food preservation:

Bacterium aceti

These are also known as "Vinegar bacteria" and cause significant spoilage in wine industry but are useful and necessary for vinegar production. These are very small, short rods, usually non-motile and generally do not form spores. These bacteria are aerobes and by oxidation they turn ethyl alcohol to acetic acid in presence of oxygen. These are of two types considering growth, one forms a tough shiny film or wine and the growth is known as "Vinegar mother" while the other type grows throughout the wine without forming vinegar mother. These bacteria can be easily destroyed at 65°C (149°F).

Lactobacilli

The organisms of this group are also known as "Lactic bacteria". It includes organisms of different properties but all of them produce lactic acid from various sugars. Those which are used in distilling and brewing industries belong to group facultative thermophiles (heat tolerants) and grow abundantly at 50°-55°C (112-131°F) and in this range of temperature lactic acid formation is more. Mesophiles are used in fermentation of pickles and L. plantarum is generally found in pickles and olives. It is found in the form of long, non-motile rods. These bacteria cause "lactic souring" and spoil the wines, although easily prevented by maintaining SO_2 (sulphur dioxide) concentration in wine.

The thermophiles causing 'flat souring' in canned nonacid vegetables also form some lactic acid but are seldom classified as lactobacilli.

Thermophiles

As mentioned before they form two groups—(a) obligate thermophiles, (b) facultative thermophiles-organisms causing 'flat sour' spoilage are present in both the groups. Some of them forming gas and resulting into 'Swells' of spoiled cans also come under thermophiles. Some of these bacteria also produce H_2S which is odd in odour and after dissolving iron it imparts blackening effect. Some of the thermophiles are obligate anaerobes and others are facultative anaerobes.

Most of these thermophiles form spores of great resistance which can survive for 30 hours at 212°F and more than an hour at 250°F. Practically the spores found in highly contaminated products of a can having low acidity cannot be destroyed by the heat process. Thermophiles are inhibited at pH 4.7 or in more acidic products but B thermoacidurans can develop in tomato juice of low pH. The spores of thermophiles are found in soil, sugars, pine lines, syrup tanks etc.

Clostridium botulinum

Bacillus botulinus has got special role in spoilage of canned products. It produces fatally poisonous toxin which is most important considering the human health. It is a common soil organism and flourishes in absence of air and is also known as "putrefactive anaerobe". These organisms have maximum resistance to heat. It develops in improperly sterilized canned foods and is very resistant to heat but a heating of at least 6 hours at 212°F destroys most of the dormant spores. The spores remain dormant up to one year. Spoiled foods should never be tasted as there is high rate of mortality up to 65% of human cases. Non-acid vegetables must be boiled for 10 minutes or longer before use which destroys botulinus toxin.

Other anaerobes

(i) *Clostridium sporangenes* resembles *Cl. botulinum* but does not produce toxin. It produces much gas, butyric odour and the spores are resistant to heat. It mostly spoils non-acid vegetables. The spores and cells also resemble to *Cl. botulinum.*

(ii) *Clostridium pasteurianum* is an acid-tolerant, anaerobic, gas producing bacteria and is cause of spoilage of tomatoes and tomato juice.

2. MOULDS

Moulds belong to that group of fungi which produce branched filaments. The common moulds consist of micro-

16453

scopic tubular filaments termed as hyphae, which are profusely branched and intervine to form a web-like structure known as mycelium. The mycelium is often white and cottony and penetrate the attacked foodstuff. After fixing itself the moulds produce viable spores which act as seeds for multiplication and resist the unfavourable conditions after dispersal and germinate when get favourable conditions.

Damp, dark and close situations associated with reasonable temperature, moisture and oxygen are the best for the growth of moulds. They may germinate even on moist leather but prefer sugar containing materials with acids and do not thrive in alkaline medium. It is the main reason that fruits and fruit products are attacked by moulds. While in growth it spoils the flavour, appearance and food value of the attacked products but never cause food poisoning like bacteria. Moulds can be easily killed if heated at 165°F for 30 minutes.

The moulds which are of most economic importance are :—

(a) Blue moulds (Penicillium)
(b) Black moulds (Aspergillus)
(c) Grey moulds (Mucor)
(d) Byssochlamys fulva

(a) Penicillium

This is also known as blue mould. In initial stages of growth these are cottony but at later stages when the spores or conidia are formed, give powdery appearance which may be blue, brown or pink according to the age. The spoiled materials give 'mouldy' odour and flavour due to its attack.

(b) Aspergillus

In the initial stages it is also white and cottony—like Penicillium but in advanced stages it becomes black with the formation of spores, that is why gnown as "Black mould". It is different to that of Penicillium and do not produce odd odour and flavour. It is generally seen attacking grapes and other fruits.

(c) Mucor

This is also known as 'pin mould' or 'bread mould' because it frequently develops on moist bread within very short periods. It is grey in colour that is why it is also known as 'grey mould'. It attacks fruits but is not so important in the preservation of fruits and vegetables as blue and black moulds described above.

(d) Byssochlamys fulva

It is a mould which causes spoilage in canned fruits. The infected fruits disintegrate and sometimes carbon dioxide gas is also produced. It can grow under reduced oxygen tension and the ascospores possess high heat resistance. For the destruction of the most resistant spores heating of the can at 190°F, preferably at 195°F is essential.

Although the organisms are not so resistant as some of the thermophiles, however their control in canned foods becomes difficult. The canned products which cannot withstand prolonged heating without deteriorating in quality are ultimately spoiled. The association of this mould with the fruit in the field has also been observed. So emphasis should be given on eliminating the organisms from the raw material instead of additional processes to destory the organisms present in the can.

3. YEASTS

Yeasts are also single celled microscopic organisms which multiply by means of 'fission', 'spore formation' or 'budding' and are also known as 'true yeasts'. The bud when becomes mature separates from the mother cell and functions like an independent organism. Yeast cells are abundantly present in atmosphere and thus found on fruits and vegetables. Yeasts need sugar and plenty of water for their normal growth and in suitable conditions the sugar is converted into alcohol and carbon dioxide gas is evolved.

Yeast + sugar → Alcohol + carbon dioxide ↑

This is the reason that from the food materials spoiled by yeasts carbon dioxide gas evolves due to fermentation and bumps out the corks from bottles with a great force. During active fermentation it can be easily recognised by formation of foams or bubbles. Yeasts prefer light sugar contents for their growth and when the percentage of sugar is increased more than 65%, it checks the growth completely. Yeast cells can be killed by moist heat and heating at a temperature of 155°F for about 30 minutes can absolutely destory the organisms. Yeasts also effect on the appearance and texture of fruits but they are not harmful for human consumption and never cause food poisoning.

Pseudo Yeasts

These are also like true yeasts and do not form spores. All the members belonging to this group are particularly undesirable for fermentation purposes as they produce off flavours and cloudiness.

C—ENZYMATIC SPOILAGE

These are chemical substances besides the above mentioned micro-organisms which play a remarkable role in changing the state of fruits and vegetables. Enzymes are the chemicals which make the ripening process of fruits and vegetables complete, but if their activity is not checked at proper time they spoil and cause final decay.

Enzymes change starch into sugar, proteins into ammino acids, pectin into pectic acids and thus the constituents of the food are changed. This action can easily be controlled by regulating the temperature and exclusion of moisture and air.

Some fruits when cut, change the colour of the flesh and it is due to the reaction of atmosphere with enzymes.

PREVENTION OF SPOILAGE AND GENERAL PRINCIPLES OF FOOD PRESERVATION

An attempt has been made in the preceding pages to present the important causes of spoilage in foods specially fruits and vegetables and it is better if the following directions are kept in mind to control the spoilage.

1. The raw materials should be thoroughly examined and handled following all the hygienic principles and should be avoided from warm conditions so as to avoid possibility of microbial spoilage.
2. The equipments must be clean at every time.
3. The cans should be carefully filled and exhausted sufficiently to produce a good vacuum.
4. Processing should take place as soon as possible after closing. The cooling process should also be done in such a manner that the cans are left sufficiently warm to dry off surplus moisture but not hot enough to cause "Stack" burning.
5. Contaminated waters if traced should be avoided.
6. The finished products after canning and bottling should be stored in well ventilated houses and in cool dry place. High storage temperatures should be avoided.

PRINCIPLES OF FOOD PRESERVATION

The two main principles which are followed in the preservation of fruits and vegetables can be tabulated as below :

A. *Temporary Preservation*
   - (i) Asepsis or absence of infection
   - (ii) Low temperatures or refrigeration
   - (iii) Exclusion of moisture

B. *Permanent Preservation*
   - (i) Sterilization
   - (ii) Antiseptics
     - a–Sugar
     - b–Salt
     - c–Vinegar

(iv) Exclusion of air
(v) Mild antiseptics
(vi) Pasteurization

d–Chemical preservatives
(iii) Fermentation
(iv) Drying

A. TEMPORARY PRESERVATION

(i) Absence of Infection

The general cleanliness while picking, grading, packing and transporting of raw material increases the keeping quality of fruits and vegetables and the products prepared by them are of very superior quality. The micro-organisms will also be minimised by the above precautions and there will be less chances of spoilage.

Washing or wiping of the fruits and vegetables before using in manufacture should be strictly followed as the dust particles adhering to the raw material accompany micro-organisms and by this method the organisms can be reduced to a very low percentage.

(ii) Low Temperatures

It has been established by recent researches that temperatures less than 50°F check the growth, multiplication and activity of micro-organisms but do not kill them. It also retards chemical changes to a greater extent.

The fruits and vegetables are either kept in refrigerators or in cold storages which depends upon the quantity of the material. The principle of maintaining the temperature for both is the same and particular desired temperature can be maintained continuously.

(iii) Exclusion of Moisture

Moisture is one of the favourable things for the growth of micro-organisms specially moulds. Particularly moisture plays a great role in dried products as it collects on the surface and results in micro-organism growth. Moisture is also responsible to dilute the concentrated sugar solutions which are generally without preservatives. The products should be saved from moisture and should be stored in a dry atmosphere.

(iv) Exclusion of Air

If the products are saved from air they prolong the keeping qualities especially fruit products. Aerobic organisms cause a great spoilage if they get external air. So fermented products and pickles must be sealed in airtight containers to check their growth.

(v) Mild Antiseptics

Sugar, salt, vinegar are used in small quantities for temporary prevention of some products. Light sugar syrup is used in canning of fruits which retains the colour, flavour and shape of the fruit products. Vinegar and spices (particularly cloves, cinnamon and garlic) check the spoilage of tomato sauce for few weeks after opening the bottle.

(vi) Pasteurization

This is a process in which the products are subjected to a temperature which kills the maximum possible micro-organisms present. It has been named after the name of the great Chemist and Bacteriologist Louis Pasteur. He proved that the organisms responsible for diseases and food spoilage can be killed by heating. This is a better method for fruit juices as practically all the micro-organisms which can grow in liquid are killed by the heat and particularly act as a permanent method of preservation.

The products preserved by the above methods can be retained from a few days to a month but the methods are not worth relying for longer durations.

PERMANENT PRESERVATION

This type of preservation strictly depends upon the materials to be preserved. The main methods used for permanent preservation are as follows :

(i) Preservation by Sterilization

By this method all the forms of life are completely destroyed due to high temperatures. It is also known as processing by heat and the time and temperature varies with different products. The fruit and tomato products should be heated up to 212°F for 30 minutes so that the spore forming bacteria which are sensitive to high acidity may be completely killed. Vegetable products require high temperatures to kill the spore forming organisms being non-acidic and containing more starch than sugar. Continuous heating for 30-90 minutes at 240°F is essential for their sterilization. Before using empty cans and bottles should also be sterilized about 30 minutes by placing them in boiling water.

(ii) Preservation by Antiseptics

It has already been explained that salt, sugar and vinegar if used in small quantities preserve the foods for a shorter period or temporarily. So for permanent preservation these things can be used in high concentrations.

(a) **Sugar**. If the concentration of sugar in the preserved material is increased about 66%, the water content is automatically decreased to such an extent that the multiplication of micro-organisms is checked and the present ones die in due course.

(b) **Salt.** Strong salt solutions never allow the micro-organisms to grow in the preserved products and a brine solution of 10-15 per cent is sufficient for permanent preservation of most of the products.

(c) **Vinegar**. Acetic acid of vinegar is more effective than sugar and salt and acts as a poison for micro-organisms. A solution of about 2 per cent of acetic acid prevents most of the products from spoilage.

(d) **Chemical preservatives.** These preservatives are used in very little quantities to check the micro-organisms as these are more effective than sugar, salt and vinegar. Benzoic acid, sulphurous acid and their salts, e.g., potassium meta-bi-sulphite, sodium-meta-bi-sulphite and sodium-benzoate are permitted by law as chemical preservatives. Borax, boric acid, salicylic acid and formaldehyde which were also used formerly, have been prohibited due to their toxic effect on consumer's health.

(iii) **Preservation by Drying**

It is the most popular method of preservation. In these days drying by dehydration has substituted the sun drying. This is a more rapid process as artificial heat of higher temperature is provided and the fruits and vegetables are dried to such an extent that the moisture content is reduced and micro-organisms fail to survive on them and it checks the action of enzymes as well. The different methods of drying will be described afterwards in detaili

(iv) **Fermentation**

Micro-organisms and enzymes are used for the decomposition of carbohydrates and the process is termed as fermentation. This is one of the oldest methods of preservation. Every care should be exercised to seal the fermented products air tight so that undesired fermentation may not take place.

(a) *Alcoholic fermentatiou*

The keeping quality of alcoholic beverages directly depends upon the alcohol present. Yeasts play an important role in this type of fermentation as simple hexose sugars are converted into alcohol and carbon dioxide as indicated below :

$$\underset{\text{Dextrose}}{C_6H_{12}O_6} + \text{yeast} \rightarrow \underset{\text{Alcohol}}{2C_2H_5OH} + \underset{\text{Carbon dioxide}}{2CO_2} \rightarrow$$

(b) *Acetic fermentatiou*

This type of fermentation follows alcoholic fermentation and is completed by vinegar bacteria *(B. aceti)* and acetic acid is produced which is the main cause of the preservation of various products such as pickles, sauce etc. The reaction involved in this fermentation is as follows :

$$\begin{array}{ccccccc} C_2H_5OH & + & O_2 & \rightarrow & CH_3COOH & + & H_2O \\ \text{Alcohol} & & \text{Oxygen} & & \text{Acetic} & & \text{Water} \end{array}$$

(c) *Lactic fermentation*

In this process the hexose sugars are decomposed into Lactic acid as mentioned below aud preserve the pickles after fermentation.

$$\begin{array}{ccc} C_6H_{12}O_6 & = & 2\ C^3H_6O_3 \\ \text{Dextrose} & & \text{Lactic acid} \end{array}$$

CHAPTER **4**

UNFERMENTED FRUIT BEVERAGES

(FRUIT JUICES. SQUASHES, SYRUPS AND CORDIALS)

All the drinks described in this chapter come under the unfermented or non-alcoholic fruit beverages. These products are becoming very popular in the market due to their nutritive and refreshing qualities. The drinks are quite cheap in preparation and due to this fact they are replacing most of the artificial drinks which were predominating in the marked. The main cause of the unpopularity of synthetic drinks is also due to their artificial colour and flavour.

Squashes and fruit syrups contain a good amount of sugar and should be diluted before use, but the fruit juices contain a little or no sugar and can be consumed after adding some sugar or in original preserved condition.

GENERAL METHODS OF PREPARATION

1. *Selection of fruit*: Matured and fully ripened juicy fruits having the characteristic colour and flavour of the particular fruit should be selected for the purpose. Overripe and green fruits if selected deteriorate the standard of the product.

2. *Sorting and washing*: Decayed, blemished and undesirable fruits as mantioned above should be rejected. The selected fruits should be washed properly to remove the dirt adhering to them. It improves and protects the finished product from future complications.

3. *Extraction of juice*: Most of the fruits are first crushed to help in the extraction of juice before pressing. Some of them also require heat process for breaking the juice containing tissues. In case of citrus fruits, the fruits should be cut into halves and then the juice can be extracted with a light pressure

on juice extractor or can be taken out by pressing the halves in small wooden juice extractors. Care should be taken that all the skin portion of the citrus fruits is removed otherwise it makes the juice bitter. Finally the juice should be strained through a thick cloth or a sieve to remove coarse portions and seed.

4. *Machines and equipments*: All the machines and equipments used in the preparation of fruit juices and squashes should be rust and acid proof. Copper and iron should be strictly avoided as copper reacts with acids and iron causes blackening of the products. Machines and equipments made of aluminium, stainless steel, tinned copper, nickel and brass with polish can be used.

5. *Clarification and Filteration of juices*: Fruit juices specially of citrus fruits should be properly decanticated, clarified and filtered. For earlier clarification chemical substances such as pectinol, casein, tanin or gelatin can be used. The clarified juices can be easily filtered through a muslin cloth, filter paper or a flannel bag.

6. *Addition of sugar*: Generally all the juices are sweetened by adding sugar but grape, apple and tomato require no additional sugar. Suga works as a type of preservative for the flavour and colour and prolongs the keeping quality. The quantity of sugar to be added depends upon the sweetness of the raw material, however 25-70 per cent sugar is used for preparation of squashes and syrups and they can be divided into three groups according to their sugar content as given below :—

(i) Lower sugar content	containing sugar below 30%
(ii) Medium sugar content	containing sugar above 30% and below 50%
(iii) High sugar content	containing sugar above 50% and up to 65%.

Sugar can be added direct to the juice or in syrup form by dissolving it in boiling water and clarified by addition of small quantity of citric or tartaric acid or some drops of lime juice and filtered.

7. Methods of Preservation of Juices and Squashes

The following are the methods which are generally used in the preservation of fruit juices and squashes :

(i) *Preservation by Pasteurization*: The heating process of fruit juices in sealed containers at a temperature of 175°F for 25-30 minutes is termed as "Pasteurization". By this method all the micro-organisms responsible for the spoilage are destroyed. The time and temperature differs according to the kind of juice but very high temperatures and too long periods of heating spoil the flavour and produce a disagreeable cooked taste to the product. Acidic fruits require less time and lower temperatures in pasteurization when compared to fruits with less acid content. All the equipments used in the process should be perfectly clean.

After filteration and heating the juice is bottled, sealed and placed on a vessel containing water and having cloth padding in its bottom and then the bottles are heated at a temperature of 175°F for about 30 minutes.

(ii) *Preservation with the help of chemical preservatives*: Juices are not preserved by the addition of preservatives but by pasteurization, as they are utilized just after opening the bottle. Syrups, squashes and cordials are diluted with water as they are preserved in concentrated form and generally the whole bottle is not consumed at a time. So there are every chances of infection as the bottle is opened several times and while pouring the liquid the micro-organisms can enter the contents accompanying the atmospheric air. The products in such cases are spoiled by the activity of these organisms and the addition of a chemical preservative is therefore essential.

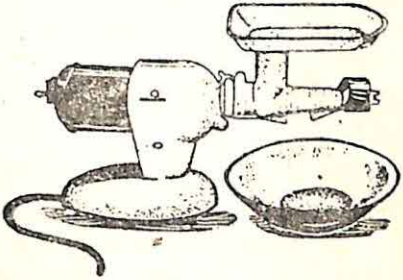

Fig. 1
Laboratory Screw Type
Juice Extractor

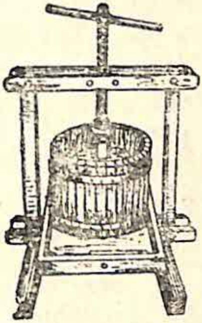

Fig. 2
Basket Press

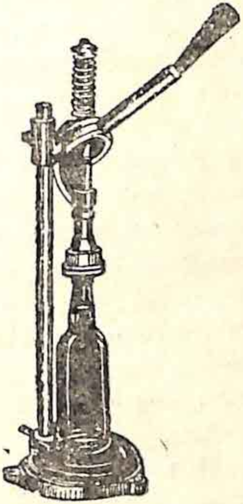

Fig. 3
Crown Corking
Machine

Formerly salicylic acid, formaldehyde, boric acid and borax were also used as preservatives and they have been now prohibited by law due to their toxic effect on the consumer's health. The chemical preservatives permitted by law are Benzoic acid, sulphurous acid and their salts. The following salts are in general use these days :

1. Potassium metabisulphite	6.250 g in 10 kg (l) of juice or squash
2. Sodium metabisulphite	5.0 g in 10 kg (l) juice or squash
3. Sodium benzoate	10 g in 10 kg (l) juice or squash

Mixing of chemical preservatives: (i) Sodium and potassium metabisulphite should not be added to highly coloured fruit such as pomegranate, jamun, phalsa etc., because these chemicals possess bleaching properties. For such juices sodium benzoate proves to be very useful.

(ii) The chemicals should be properly weighed according to the prescribed quantity only. If it is used in larger quantities it directly affects the human health and if used in lesser quantity, its preservative action is minimised according to the quantity used.

(iii) The required quantity of preservative is first dissolved in a little quantity of water or the juice to be preserved and added to the whole lot by thorough mixing.

(iv) The preservatives should not be used in tin containers because they react with the tin and produce very disagreeable odour, and the tin with the contents is blackened.

(v) Sodium benzoate should be used in chemically pure form which is odourless and tasteless, as ordinary chemical imparts bad taste and odour.

(vi) Acids should be added to the products after thoroughly mixing sodium benzoate otherwise a white precipitate may be formed which creates a difficulty and is not dissolved even after thorough mixing.

8. *Bottling*: The bottles should be thoroughly washed with hot water and while filling it should be observed that 1.5-2.5 cm space is left at the top. Either a cork is inserted tightly in the mouth of the bottle or a crown cork (cap) is fixed by means of the crown corking (capping) machine.

A—PREPARATION OF FRUIT JUICES

1. *Tomato juice*: The tomatoes selected must be fully ripe, red in colour and free from bruises and diseases. They should be washed thoroughly and the green portion is removed with a stainless steel knife and then cut into small pieces. The fruits are then crushed thoroughly in a stainless steel or aluminium vessel with a wooden laddle. The pulp thus obtained is cooked for 4 to 5 minutes and is mashed well while cooking. After removing from the fire it is strained through a piece of mosquito net cloth, stainless steel or aluminium sieve. The pulp must be rubbed with the bottom of a clean cup so that only the juice may be sieved and the seeds and skin are left behind.
Recipe:

Extracted juice	1 kg (l)
Sugar	4.30 g
Common salt	6.43 g

The finished product must be poured leaving 2.5—3.0 cm space in hot sterilized bottles which have been kept in boiling water for at least half an hour, and sealed airtight with crown corks (which have also been kept in boiling water for 2-3 mts before use).

The filled bottles must be kept in boiling water again for 30 minutes. The pan containing this water should have a 'false bottom' (a double or 4 folded thick cloth placed at the bottom of the pan).

The juice can also be preserved by the addition of sodium benzoate 0.460 g per lb or 1.0 g per kg (l) of juice. It can be stored without pasteurization and lasts longer after opening the bottle.

The bottles should be cooled and stored in a cool dry place.

2. *Pineapple juice*: The fruits selected should be fully ripe with characteristic aroma and flavour. Remove the crown and peel the fruit with a stainless steel knife. Remove the eyes and damaged portions, if any. Cut the fruits into small pieces and take out the juice through a thick muslin cloth.

Take 28 g sugar for 1 lb juice or 62 m sugar per kg (litre) juice, mix and again strain through a coarse muslin cloth.

Method of preservation: As for tomato juice (No. 1).

3. *Pomegranate juice and syrup*: Select pomegranates like Kandhari variety with richly coloured grains. Cut the fruits into quarters, remove the grains and press in a basket press. Filter through a thick cloth and bottle. It can be stored as mentioned for tomato juice. The juice should not be stored for a longer time as the flavour is weakened in storage due to its delicate nature. Preserve the juice—as recommended for tomato juice (No. 1).

If desired the juice can also be converted into a syrup of 55°-60° Brix.

B—PREPARATION OF SQUASHES

1. *Bel squash*. Select ripe 'bel' fruits with good aroma and flavour. Cut the fruit with a sharp knife or saw into small pieces. Remove the rind and seed portion. Crush the pulp and add 1/4th. water according to the quantity of pulp. Mix the ingredients and extract the juice through a muslin or mosquito net cloth and follow the following recipe.

	I		II	
Juice	1.0	lb.	1.00	kg.
Sugar	1.66	,,	1.66	,,
water	0.40	,,	0.40	litre

Mix the sugar and water thoroughly, add citric or tartaric acid according to the taste, warm slightly if necessary, strain through a thick cloth and now mix the extracted fruit juice. Add sodium benzoate 0.460 gm. per lb. or 1.00 gm. per. kg. of the finished product.

2. *Jamun squash*: Select fully ripe deep purple coloured fruits free from bruises. Crush the fruits cautiously so that the seeds are not broken. Take 1/2 kg (1/2 litre or 500 ml) water for 1 kg. pulp and warm for 5 mts. Extract the juice through a thick cloth and following the following recipe.

Jamun juice	1 kg
Sugar	1 2 kg
Citric acid	17.2 g

Mix the above ingredients thoroughly, warm slightly and strain through a thick cloth and add sodium benzoate 0.460 g. per lb or 1.0 g per kg of the finished product. Pour the squash in previously sterilized bottles and cork them properly. Store the bottles in cool dry place.

3. *Lemon squash*: (a) Select lemon fruits preferably kagzi lime, fully ripe, pleasing yellow in colour and free from disease. Wash the fruits thoroughly and cut into halves with sharp stainless steel knife and remove the skin. Extract the juice with small bucket press or lime squeezers and strain the juice through a coarse muslin cloth to discard the seeds etc.

	Medium sugar content (45%)	High Sugar content (65%)
Juice	1 kg	1 kg
Sugar	1.3 kg	2 kg
Water	850 ml	200 ml

The above ingredients must be thoroughly mixed by slight warming to obtain proper and rapid mixing. For maintaining the desired shade some edible colour may be added to the finished product after dissolving in water. After mixing the ingredients the product can be strained through a coarse muslin cloth for removal of dirt etc., and finally potassium metabisulphite at the rate of 0.325 g per lb. or 0.715 g per kg (litre) of the finished product is added.

The finished product is now poured in bottles which have been previously sterilized in boiling water for about 20 minutes. The bottles should be securely corked and stored in cool dry place.

(b) A simple method of lemon squash preparation which can be very easily followed is given below:

Take a clean bottle and fill it with sugar crystals up to the neck of the bottle leaving 3.5—5.0 cm space at the top. Take extracted and well strained lime juice and make the sugar saturated with this juice, cork the bottle and put it in the cool dry sun for 2 to 3 days. Cork the bottle tightly and store it in a place. This squash is very high in sugar content and requires no chemical preservative.

4. *Litchi squash*: Select fully ripe litchi fruits free from bruises and diseases. Peel the fruits and take out the stone. Heat the pulp in a small quantity of water for few minutes under a low flame. When the pulp becomes soft, squeeze the juice through a thin cloth.

Juice	1.0 kg (1.0 l)
Sugar	1.537 kg
Water	537 ml
Citric acid	24.662 g

Mix the above ingredients thoroughly as in lemon squash and add potassium metabisulphite 0.625 g per kg (litre) of the finished product.

Bottling and storage should be done as for lemon squash (No. 2).

5. *Mango squash*: Take sucking mangoes specially from Deshi (seedling) type, which are best suited for squash making.

The fruits should be fully ripe and free from bruises and diseases. Wash the fruits thoroughly and remove the stems. Press the fruits lightly between the palms of the two hands leaving the least quantities of pulp with skin and stone.

	Medium sugar	*High sugar*
Mango pulp	1 kg	1 kg
Water	1 kg (1 l)	0.666 l
Sugar	1 kg	1.666 kg
Citric acid	30.865 g	32.2 g

Orange edible colour—sufficient to bring out attractive appearance.

Mix the above ingredients avoiding heating. Add potassium metabisulphite 0.715 g per litre (kg) of the finished product.

Bottling and storage the same as for lemon squash (No. 2).

6. *Orange squash*: Select fully ripe oranges free from diseases. Wash the fruits thoroughly and cut into halves with a stainless steel knife. Extract the juice with an orange juice extractor and collect into a glass enamel, aluminium or stainless steel pan. Strain the juice through a piece of cloth to discard the seeds and other coarse particles.

	Medium sugar content (45%)	High sugar content (65%)
Juice	1 kg	1 kg
Sugar	1.25 kg	1.55 kg
Water	750 ml	—
Citric acid	55 g	44 g

Orange colour—sufficient so that the colour may be pleasing after dilution.

Essence of orange 46.0 g

The above ingredients must be thoroughly mixed. Add 0.715 g per kg (l) of the finished produce.

Bottling and storage the same as for lemon squash (No. 2).

7. *Phalsa squash*: Select fully ripe fruits free from bruises and attack of diseases. Take 1 kg of fruit in a vessel, add 3/4 kg (750 ml) water and heat for 10-15 mts on a low flame. Crush the fruit thoroughly with a wooden laddle and strain the juice through a thick muslin cloth.

	Low sugar content	High sugar content
Phalsa juice	1 kg	1 kg
Sugar	0.6 kg	1 kg

The above ingredients should be mixed thoroughly. Add sodium benzoate 0.460 g per lb or 1.00 g per kg of the finished product.

8. *Pineapple squash*: Select fully ripe fruits free from bruises and diseases. Peel the fruits and remove the internal hard portion. Cut the fruit into small pieces and take out the juice by pressing through a thick muslin cloth and follow the recipe and other precautions as mentioned for Litchii squash (No. 3).

9. *Sapota squash*: Take fully ripe fruits with characteristic sweet and pleasant aroma and just soft to touch. Wash the fruits properly and remove the outer skin with a stainless steel knife. Cut the fruits into pieces and remove the seeds and fibrous threads. Wrap the pulp in a thick cloth, press out the juice and follow the following recipe:

Juice	1 kg (l)
Water	1 kg (l)
Sugar	1 kg
Citric acid	42 g

Mix the above ingredients thoroughly and add potassium metabisulphite 0.715 g per kg. Sodium benzoate may also be used in place of potassium metabisulphite, but it is used 1.140 g per kg.

C–PREPARATION OF FRUIT SYRUPS

Fruit syrup is prepared from fruits like Phalsa, jamun, grapes and pomegranate. The fruits should be free from diseases and bruises. Wash the fruits, remove the seeds, skin and stones. Mash the edible parts and add 250 ml (1/4 kg) water per kg. of pulp and warm for 2-3 minutes. Extract the juice through a coarse cloth and following the following recipe.

Fruit juice	1 kg
Sugar	1 kg
Citric acid	8.10 g

(only in jamun and grape syrups)

Mix the above ingredients thoroughly, warm slightly and strain through a coarse cloth. Add sodium benzoate at the rate of 1.140 per kg of the finished product. The product is then poured in previously sterilized bottles. The bottles should be securely corked and preserved in cool dry place.

D–CORDIALS

Lime juice cordial: The lemon fruits preferably kagzi lime should be fully ripe, pleasing yellow in colour and free from diseases.

Wash the fruits thoroughly and cut into halves with sharp stainless steel knife and remove the skin. Extract the juice with small bucket press or lime squeezers and strain the juice through a coarse muslin cloth to discard the seeds etc.

Clarification: Pour the juice in large sized glass containers or wooden barrel by adding potassium metabisulphite at the rate of 1-325 g per kg of juice and put it for about a month. Decant the clear juice without disturbing the sediment and then strain it through a fine muslin cloth.

	Medium sugar cordial	High sugar cordial
Juice	1 kg	1 kg
Sugar	1.225 kg	2.225 kg
Water	1 kg (l)	85 ml

The above ingredients should be mixed and can be warmed if necessary. Add potassium metabisulphite at the rate of 0.360 g per kg of the finished product.

Fill the finished products in thoroughly cleaned and previously heated bottles leaving 2.5—3.5 cm space at the top. The bottles should be corked tightly or crown corked. Store the bottles in cool dry place.

E—LEMON BARLEY WATER

Select the fruits as for lime juice cordial and extract the juice in the same way.

Take 113.4 g barley flour prepared from decorticated barley grains and dissolve it into water and make a thin paste and make the contents to 4.5 litre (kg) by adding more water. Heat it for 5-10 minutes and filter hot through a muslin cloth and cool.

Recipe:

Barley extract	1 kg
Sugar	2.5 kg
Lime or lemon juice	1 kg

The above ingredients should be mixed thoroughly and can be warmed if necessary. Add potassium metabisulphite 0.715 g per kg of the finished product.

Bottling and storage—The same as for lime juice cordial.

II. FLAVOURED DRINKS

These drinks are mostly preserved by sugar, therefore it should be at least 70 per cent in the finished product. The drinks under this head can be broadly divided into two groups.

1. Drinks prepared from flowers and Khus—Rose, Kewra and Khus.
2. Synthetic drinks containing artificial colour and flavour—Lemon, orange, banana, mango etc.

Method of preparation: Take the desired quantity of water and put it for boiling. Add the recommended quantity of the sugar and dissolve it by stirring. After dissolving the sugar proporly make the flame low and add citric or tartaric acid, remove the pan from flame and strain the syrup through a thick cloth. Add the other ingredients according to the following recipe.

The edible colour should be dissolved in a little water and should be added after filtering it. Fill the product in clean and dry bottles, cork securely and store in cool dry place.

1. *Recipe for drinks prepared from flowers and khus*

Sugar	1 kg
Water	335 ml
Flower of khus extract	110 ml (g)
Citric or tartaric acid	2.25 g

Edible colour—sufficient to give pleasing colour.

2. *Recipe for synthetic drinks*:

Sugar	1 kg
Water	0.75 kg (l)
Citric or tartaric acid	2.25 g
Essence	7.9 ml

Edible colour—sufficient to give attractive colour.

III. CARBONATED FRUIT BEVERAGES

Practically the use of fruit juices in the preparation of carbonated drinks is uncommon in India. Mostly flavoured drinks are prepared by this method, which constitutes no nutritive value. The use of fruit juices may increase the food value of carbonated fruit beverages.

The juices can be directly carbonated and can be stored in their form or in the concentrated form and the carbonated products can be retained in original form for about a week without addition of preservatives. If the products are to be kept for longer period, addition of 0.05 per cent sodium benzoate to the finished product is essential.

For example, while preparing orange syrup for carnocation, the syrup should be heavy. It should be made by mixing juice, sugar and citric acid in the ratio of 1:1.55: 0.4375. For carbonation 42.56 g of this prepared syrup should be filled in a 285-340 g bottle. In the same manner syrups of pineapple, lime, lemons etc., can also be preserved.

CHAPTER 5

FERMENTED FRUIT BEVERAGES

(WINE, CIDER, PERRY, BERRY WINE, CHAMPAGNE, MUSCAT, ORANGE WINE ETC.)

'Wine' is generally prepared after fermenting the grape juice. "Cider" from apple juice and "perry" from pear juice. The fermentation of these drinks is confined only up to alcoholic fermentation but in the case of vinegar it is prolonged up to acetic or vinegar fermentation.

I—PREPARATION OF GRAPE WINE

1. *Selection of fruit*: The selected grape berries should be ripe and fresh. The blemished portions must be removed.

2. *Juice extraction*: Crush the berries and extract the juice by putting them in thick muslin cloth.

3. *Pasteurization*: The juice is pasteurized at a temperature of 140-150°F (60-66°C) for 30 minutes which settles the dirt and checks the growth of wild yeast.

4. *Fermentation*: Syphon off or filter the juice and put this clear juice in a clean carboy and adjust the sugar content to 23°Brix either by adding sugar or water according to the sugar percentage of the juice.

Take pure strain yeast (*Saccharomyces eilpsoideus* var. Burgandy) from a reliable bacteriological laboratory and add 85-110 ml of pasteurized juice to the culture bottle. Let the organisms multiply and after about 2 hours a frothing on the surface of juice can be observed and it indicates that the fermentation is complete. The fermented juice is mixed in pasteurized juice in 1:10 proportion which completely ferments within 24 hours. The process is repeated in the same proportion at a maintained temperature of 80°-85°F. When the fermentation is checked artificial filtered aeration can be done by air pump. The complete fermentation takes about 21 days and the sugars are completely changed into alcohol within this period.

5. *Clarification and syphoning*: The clear wine is syphoned as mentioned for vinegar and the precipitate is left behind. The process is repeated for several times and the syphoned wine is securely stored in air tight containers.

6. *Aging*: To the clear wine oakwood shavings are added which oxidise and impart a nice oaky flavour within the storage period of one or two years.

7. *Bottling and pasteurization*: The ready wine should be bottled properly and pasteurized at 140°-150°F (60-66°C) for 30 minutes.

Dry wines: The wines which are prepared by converting all the sugars, present in the original juice, into alcohol by fermentation are termed as "Dry wines".

Sweet wines: "Sweet wines" are those in which the fermentation of the sugars is stopped in the middle of the process.

The alcoholic content in the above wines ranges from 7-20 per cent.

II—PREPARATION OF APPLE CIDER

1. *Selection of fruit*: Select full ripe apple fruits with well developed aroma and flavour. It should possess high tannin content which is one of the necessities for cider making.

2. *Preparation of fruit*: Wash the fruits thoroughly and grate the fruits on a grater and take out the juice by pressing through a thick cloth and collect the juice in a stainless steel or aluminium vessel.

3. *Clarification*: Strain the juice prepared by the above method through cotton wool or filter paper so that the coarser particles may be discarded.

4. *Fermentation*: To the clarified juice add potassium metabisulphite at the rate 0.215 g per kg. Add sugar to make the juice 22°Brix. Now to this juice add pure wine yeast to effect fermentation. Plug the mouth of the carboy with cotton wool and maintain the temperature between 65-70°F (19-21°C). If the fermentation is not proper ammonium hydrogen phosphate at the rate of 0.02-0.05% which acts as nutrient can be added to activate the growth of the yeast cells.

5. *Packing*: When the fermentation is complete, i.e., the Brix hydrometer shows 0° or 1° Brix, then the fermented juice is called cider and is allowed to stand. The precipitate and the sediment settle and then the cider is syphoned. This process is repeated several times and ultimately strained through a thick cloth. Now the clear liquid is obtained.

Aging: As in the case of wine it is also supplimented with oakwood shavings or kept in oakwood vessels for developing nice flavour.

Pasteurization: The cider is pasteurized at 180°F (82°C) to inactivate the micro-organisms and coagulate the proteins, cooled and then filtered.

Bottling and carbonation: The filtered cider is carbonated under 10-15 lb pressure of carbon dioxide in pressure resistant bottles.

Final pasteurization: The filled bottles are finally pasteurized at 140°F (60°C) for 30 minutes using a false botton so that the breakage may be avoided.

III—PREPARATION OF PEAR PERRY

The same method of preparation as recommended for Apple cider should be followed. The only difference in this product is that pear fruits are used instead of apple fruits and the drink is known as "Pear perry" instead of "Apple cider".

IV—BERRY WINES

Wines prepared from berries, like strawberry, elderberry, loganberry etc., are known as "Berry wines". These products are not common in India and generally popular in other countries.

V—CHAMPAGNE

It is a sparkling wine prepared in France from certain grape varieties. It is prepared in other countries as well. The fermentation is procedeed in bottles and specially made to withstand the gaseous pressure produced while preparing.

VI—MUSCAT

It is prepared from muscat grapes in Italy, California, Spain and Australia.

VII—ORANGE WINE

The extracted orange juice is sweetened by adding sugar and then fermented. Other methods are as for grape wine. Oil should not be allowed in the juice as it hinders and sometimes stops the fermentation process.

VIII—PORT

It is a fortified sweet red wine generally made in Portugal and some other countries.

IX—SHERRY

A Spanish wine, matured by placing the barrels in the sun for 3-4 months, where the temperatures are as high as 130-140°F.

X—TOKAY

This is a very famous fortified wine prepared in Hungary.

CHAPTER 6

VINEGAR

In India the preparation of vinegar has been in practice from the time immemorial. It contains characteristic aroma and flavour with about 5 per cent acetic acid. In trade, it is named according to the material used for preparation. Vinegar prepared from malt is called "Malt vinegar", from apple juice, "Cider vinegar" and so on.

Vinegar is that product which is obtained as a result of fermentation of sugary substances. It is generally prepared from the fruits and vegetables unfit for other fancy products and table purposes. Sometimes sweet washings and peelings of fruits are also used for the purpose.

PREPARATION OF VINEGAR

Vinegar is prepared by the undergiven methods :

A—Slow process, B—Orleans slow process, and C—Quick 'Generator' or 'German' process.

A—SLOW PROCESS

This process is generally followed in India. The fruit juice or sugary solution is filled in earthen pots or wooden barrels and is subjected to automatic alcoholic and acetic fermentations without any care and least cleanliness. The hole of the container is covered with a cloth to check the insects, dirt etc., and it is kept in a warm but damp place. The preparation of vinegar by this method takes at least 5-6 months and has got many defects of which the main ones are as under :—

(i) Incomplete alcoholic fermentation; (ii) Slow acetic fermentation; (iii) Low yield; and (iv) Inferior quality of vinegar.

B—ORLEANS SLOW PROCESS

This is a method of preparation of vinegar which can easily be followed. The vinegar prepared by this method is clear and of superior quality.

1. **Selection of fruit:** Take third grade fruits of grapes, apples, oranges, mangoes, dates, jamun, or any sweet fruit having 10-20 per cent sugar content in its juice. Discarded cores or peels of certain fruits while canning and jam making can also be used for the purpose.

2. **Extraction of juice:** The juice can be taken out after cutting the fruits or vegetables into small pieces and crushing or pressing them through a thick muslin cloth. The fruits which do not give the juice readily can be heated before pressing for juice extraction.

3. **Adjustment of sugar:** The percentage of sugar present in the juice should be determined by means of a Brix hydrometer. Syrup of low concentrations are very favourable for the growth of yeast. So it should be adjusted from 12-15% either by diluting the juice with water, if the sugar content is in excess or by adding additional sugar to reach the desired concentration.

4. **Fermentation:** The juice is first heated (pasteurized) to destory the micro-organism and then transferred to sterills-ed glass carboys, earthen pots or wooden barrels (Fig. 4) fillling the container three-fourth. There are two important steps in the preparation of vinegar :—

A. Alcoholic fermentation.
B. Vinegar fermentation.

A. *Alcoholic fermentation*—Pure wine yeast which can be obtained either from a winery or in the form of compressed cakes from a chemist's shop is added at the rate of 1.52 g per litre. The yeast should be well powdered and dissolved in a little warm juice and then mixed to the whole lot and the contents

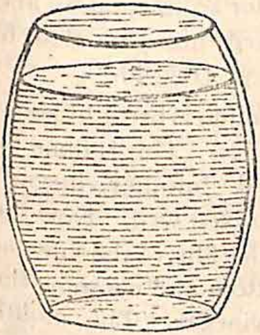

Fig. 4
Wooden Barrel
Placed Vertically
For Alcoholic
Fermentation

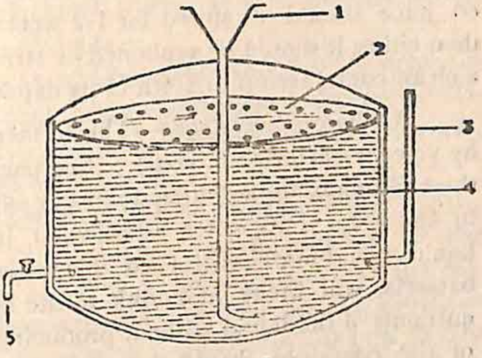

Fig. 5
Vinegar Fermentation
By Vinegor Bacteria
1. Funnel, 2. dise with hole,
3. Level indicator, 4. liquid
5. outlet.

should be frequently stirred. The mouth of the carboy or barrel should be plugged with cotton wool so that carbon-dioxide gas may get favourable conditions for escapting in the atmosphere. The gas should be properly driven out otherwise it hinders in the yeast fermentation. In the initial stages there will be a rapid frothing which indicates the progress of fermentation but it ceases after 3 weeks. When the fermentation is complete the frothing will subside and the whole of the sugar will be converted into alcohol which can be tested with a Brix hydrometer which will show 0° or 1° Brix.

Temperature: In the above process (alcoholic fermentation) the temperature should be maintained between 80-90°F (27-32°C) as the fermentation ceases above 105°F (46°C) and below 70°F (21°C).

Straining: The vinegar fermentation should be taken up after ascertaining that the alcoholic fermentation is complete, otherwise the yeast will retard the fermentation. The fermented juice should be stored for 1-2 weeks for sedimentation and then either it should be syphoned or strained through a cloth in a clean container up to 3/4th of its capacity. (Fig. 5).

B. *Vinegar fermentation*—This fermentation is brought about by vinegar bacteria (*B. aceti*). (See page 34). This is done by the addition of unpasteurized vinegar called "mother vinegar" in the ratio 1:10, after addition it is mixed well. Now the liquid should not be disturbed otherwise the film of the vinegar bacteria will break and sink to the bottom and consume the nutrients of the liquid without producing vinegar. The mouth of the container should be plugged with a cork leaving two holes for proper aeration. The temperature of this liquid should be maintained at 70-80°F (21-27°C) and the fermentation should be completed in 10-15 weeks when the acetic acid reaches its maximum.

After the vinegar is ready it should be syphoned or strained through a thick cloth leaving a portion at the bottom with the precipitated turbid liquid, which is used as "mother" vinegar for fresh lot.

5. **Aging:** The vinegar prepared by the above method is turbid and does not possess good taste. It can be stored in containers for a year before bottling. During this storage the vinegar develops a good aroma and flavour and the dirt etc., settle on the base of the container.

6. **Clarification:** This clear liquid should be syphoned and refiltered.

7. **Pasteurization:** The vinegar should be poured in previously sterilized bottles corked air tight and should be heated (pasteurized) in hot water at 160-170°F (71-77°C) for 15-20 minutes, so that the further growth of the vinegar bacteria is checked and the strength may be maintained.

8. **Colouring:** Caramel colour is used as an external colouring material for vinegars.

Note: An ideal vinegar should constitute about 0.3% sugars in the finished product, higher percentages denote incomplete fermentation due to the excessive amount of acetic acid during yeast fermentation.

C—QUICK 'GERMAN' OR 'GENERATOR' PROCESS

In this process additional oxygen is supplied for the bacteria and the surface of the bacterial culture is also increased to result speedy fermentation. An equipment known as "Upright Generator" forming a cylinder of 10-14 ft (3 0 to 4.24 m) high and 4-5 ft (1.2 to 1.5 m) in diameter is used for the purpose (Fig. 6). Mainly it consists of three compartments:

(i) Distributing, (ii) Central; and (iii) Receiving compartment.

(i) *Distributing compartment*: This is the uppermost chamber and is about one foot above the central one. It is separated from the Central chamber by a partition having small holes (perforated). In the distributing compartment there is a 'W' shaped tilting trough or revolving sprinkler which is fitted just to distribute the trickling liquid slowly over the material filled in the Central compartment. When one side of the trough is filled and the second one tilts, it takes the place of previous one, it is filled and then again tilts. This process is repeated in normal course and thus the sprinkling is continuous.

(ii) *Central Compartment*: This chamber is filled with pumice stone, straw, corn cobs, rattan or beech wood shavings just to increase the surface area but most commonly beech wood shavings are preferred as they retain their tightly coiled condition even when wet with vinegar. Near the bottom of this compartment there are adjustable openings for air.

(iii) *Receiving Compartment*: This is the last chamber or bottom compartment of the generator which is separated from the central one by perforated partition placed about 5 ft. above the bottom of the generator. This is the chamber in which the vinegar is collected.

Method of Vinegar Preparation by Quick Process: The beech shavings or the filling material in the central compartment is sprinkled and wetted with unpasteurized vinegar. It is further fed slowly with a mixture of alcoholic juice and vinegar (2:1) through the generator just to encourage the growth of vinegar bacteria of unpasteurized vinegar. The bactaria grow within a few days for the proper functioning of the generator. As soon as the generator is ready the alcoholic liquid is mixed with mother vinegar in the ratio of 1:2 to increase the acidity from 3 to 3.5 per cent. The mixture is then passed through the generator and it converts the remaining alcoholic liquid into acetic acid during this single passage. This process can be repeated continuously for further preparations in the way described above.

Precautions: 1. To eliminate the undesirable micro-organisms it is essential to clean the compartments and air passage at proper intervals.

2. The optimum temperature for the activity of vinegar bacteria should be maintained at 80-85°F (27-30°C) which can be regulated by the air intake in the generator, and the rate of the flow of the liquid. When the temperature increases, the rate of flow of acidified alcohol should be increased and the intake of air should be decreased. If there is a decrease in temperature the passage of air should be increased and the rate of the flow of the liquid may be reduced.

3. For proper functioning in all seasons, the generator may be fitted with coils in which steam or cold water may be passed to maintain the desired temperature.

CHAPTER 7

JAM, JELLIES AND MARMALADES

Jam: A product of moderately thick consistency prepared by boiling the whole fruit pulp and sugar without retaining the shape of the fruit is termed as "Jam".

Jelly: A semi-solid mass prepared by boiling fruit juice with sugar is known as "Jelly". Clear, translucent and attractive colour with the original flavour of the fruit are the main characters of a perfect jelly. It should not be sticky, gummy or syrupy but possess the qualities of a nice jelly and should leave a sharp edge when a portion of it is taken out with the knife.

Marmalade: The jelly which consists of suspended shreds of fruit peels is called "Maramlade". It is a product generally prepared from citrus fruits.

PREPARATION OF JAM

All varieties of fruits including some of the vegetables can be used for jam making. The fruits and vegetables which are generally used are mangoes, apples, pears, peaches, apricots, plums, figs, strawberries, goose-berries, pineapples, carrots and tomatoes.

Selection of the fruit: Select well ripened, sound and soft fleshed fruits.

Preparation of fruit: Wash the fruits thoroughly. The fruits possessing heavy skin must be peeled and the cores and stones should be removed. Boil the fruits or their convenient pieces for few minutes in a small quantity of water for giving a softening effect to the pulp.

Quantity of sugar required: This factor varies with different types of fruits and particularly due to their sugar content and ripeness. Sweet fruit with low acid content generally require less sugar and in some cases the ratio of pulp and sugar can go up to 1:½. But a general recommendation for tart (sour) fruits is equal amount of pulp and sugar (1:1).

Mixing and cooking: Mix the soft pieces of the fruit with the desired quantity of sugar and start cooking first on medium fire and then increase the flame so that the fruit pulp and sugar are thoroughly mixed and the product becomes of a desired consistency. In this process the sugar changes its form which does not crystalize easily. The process should be done very rapidly and prolonged boilings should be avoided as it deteriorates the flavour and colour both. Occasional stirring of the mass is essential till the temperature reaches (ranging from) 218-222°F (104-109°C) at sea level for different fruits. (For every 500 ft or 150 m rise in altitude, a decrease of 1°F (0.5°C), should be effected in the above cooking temperature.

Bottling and storage: Remove the product from fire when it reaches the desired temperature and fill it in bottles thoroughly cleaned and previously sterilized in boiling water for 20-30 minutes. The bottles should be properly capped and stored in a cool dry place.

Precautions: 1. The fruits containing no or low pectin may not set properly. In such cases some other fruit pulp rich in pectin should be mixed for proper setting.

2. If the fruit is low in acid content, some lemon juice, tartaric or citric acid can be mixed while cooking the pulp.

3. While cooking the ingredients should be stirred properly, otherwise it may char and may result in the spoilage of the whole product.

4. The upper surface of the jam should be covered with a thin film of paraffin wax before capping which keeps the jam for a longer period. If it is to be consumed soon, there is no necessity of this waxing.

JELLY MAKING

Pectin, sugar and acid are the three essential constituents of jelly. The proper setting and the quality of jelly depends upon the proper proportions of these ingredients.

A—Pectin: It is a constituent which is found almost in all the fruits and some vegetables but its content differs in different fruits. Guava, wood apple, sower plums, sour apples, roselle, mulberry etc., are very rich in pectin content and make a good jelly. When the fruit is in hard stage it is found in the form of pectose and converts into pectin according to the ripening of fruit and ultimately converts into pectic acid when the fruit passes full maturity stage and undergoes decomposition. It is pectin which is responsible for proper setting of jelly. Fruits possessing pectose or pectic acid in abundance spoil the jelly. Pectin is abundant in matured but slightly unripe fruits in between the skin and pulp and around the seed. For extracting pectin the fruit is boiled in water until soft. This process of extraction should be completed rapidly as the pectin is hydrolysed and losses the power of setting in prolonged cookings.

Determination of pectin content: Decant some clear extract from the pan, cool and take a teaspoonful of it in a test tube and add two teaspoonfuls of methylated spirit or alcohol cautiously by the sides of the test tube. After addition, give it a little shake and then pour into a vessel and note:

1. If it falls in one clot, it indicates that the extract is rich in pectin and the boiling should be stopped immediately.

2. If two or more clots, then medium in pectin content.

3. If there is no clot or a thin gelatinous mass with small flaky pieces are formed, the extract is supposed to be poor in pectin and the jelly prepared from such juice results into failure.

Note: If the contents have been cooled for a shorter period and the test gives the results as mentioned in 2 and 3 it can be boiled for concentrating for some more time up to a maximum of 45 minutes or be mixed with such fruit juice which may be rich in pectin, e.g., wood apple or roselle.

B. **Sugar:** It gives necessary sweetness and body to the jelly. It also acts as a preservative due to its higher content in the product being about 65-68%. The sugar to be used must possess refined crystals, and its quality depends upon the pectin and acid content of the fruit as mentioned below :—

1. Juice rich in pectin content— 3/4-1 kg sugar to 1 kg juice, i.e., 3/4 to equal in amount.
2. Juice low in pection content— Half to three-fourth ($\frac{1}{2}$-$\frac{3}{4}$ kg) sugar per kg of juice.
3. Juice poor in pectin content— Either should be concentrated or mixed with fruit juices rich in pectin.

Note: It is better if the sugar is added in 3 instalments, so that it may be dissolved properly. If some acid is also added to the ingredients it clears the dirt etc.

C. **Acid:** It has been mentioned before that it is one of the main constituents responsible for proper setting, so the fruit juices low in acid content must be supplimented with citric or tartaric acid or lemon juice. Some fruits like sour plums and roselle can also substitute acids if mixed with other fruits. The fruit juice can tested for acid content by the undergiven method.

Take one teaspoonful of kagzi lime juice and dilute it ten times, add 1/2 teaspoonful of sugar and shake well. Taste this juice as well as the extracted fruit juice. If extracted one is less acidic then the deficiency must be completed by adding any of the above mentioned acids.

PREPARATION OF JELLY

Selection of fruit: Take mature and unripe fruits free from diseases and over-ripe portions.

Preparation of fruit: Wash the fruits thoroughly and cut them into small pieces so that pectin and acid may be easily extracted. The water added to the slices or pieces of the fruit should not be more otherwise it dilutes the juice to such an extent that jelly will not set. It is advisable to add water just sufficient to cover the fruit pieces. If the water is less, it may also affect the yield of the juice as the fruits in the bottom may get charred.

Cooking of the fruits: Generally soft fruits require less time in boiling but the hard fruits take more time. The fruit pieces should be boiled until it becomes tender and the pectin come out in the water. Apples may be heated for 15-25 berries minutes, 2-3 minutes and guavas for 30-35 minutes, oranges 45-60 mts., roselle 20-25 mts., jamun 20-25 mts., and grapes 5-10 mts.

Juice extraction: The juice should be extracted by hand press through a thick cloth by putting the soft fruit pieces and water in the cloth. The clearer the juice the brighter the finished product (jelly).

Pectin and acid test: The juice thus obtained should be finally tested for pectin and acid content as mentioned before.

Addition of sugar: The sugar is added according to the pectin content as mentioned before.

Final cooking: The ingredients after mixing sugar should be boiled in a shallow vessel to cause rapid boiling as prolonged boiling results in loss of flavour, destroys jellying property of pectin and darkens the liquid. The scum which comes out on the surface during boiling should be removed and the boiling should be continued till the temperature reaches 221°F or when it gives a "sheeting test" (i.e., if held in the spoon starts dropping in flakes and if dropped in a glass having some water, the mass settles down in a firm position and does not dissolve in water). It is the end point at which the jelly must be removed from the fire or flame.

Bottling and storing: The finishing product must be finally poured into sterilized bottles or glass jars removing the scum. When the product has cooled a little, pour a thin layer of melted wax of 0.5 cm in thickness if it is to be stored. If it is to be consumed soon, no waxing is required. Seal and store in a cool dry place.

Causes of failure in jelly making

1. If too much water is added in the beginning the juice is diluted as explained before and the process ends into a complete failure.

2. Too much sugar also results in a syrupy jelly so it must be added according to the pectin content.

3. Prolonged boiling destroys the jellying properties of the pectin due to its hydrolysis and the jelly fails to set.

4. Higher sugar content (more than 70%) and less acid result sugar crystals in the product.

5. Lack of acid or pectin or both in the fruits used for jelly making may result in failure of setting process. It may also occur due to less time of cooking due to which it is not possible to extract the acid and pectin properly.

6. If the cooking is stopped before sugar concentrates to 65 per cent, the jelly fails to set and is syrupy or very soft.

'Cloudy' or 'Foggy' jellies: It is caused due to the following reasons: (i) If unclarified juice or extract is used, (ii) If immature starchy fruits are used, (iii) Overcooked jellies become gummy and sticky and due to their excessive viscosity do not look clear in the bottles, (iv) Due to overcooling, the viscosity is increased and sometimes become lumpy and are almost cloudy or foggy, (v) Due to faulty pouring from a great height, bubbles are formed after incorporating with the air, so the jelly should be poured from a height of about 2.5 cm, (vi) The removal of scum is also important which ultimately results in a foggy jelly, and (vii) Due to excess of pectin, premature gelation may take place and the jelly becomes opaque.

'Syneresis' or 'Weeping' jelly: The process of exudation of fluid from a gel, spontaneously is known as 'weeping' or 'syneresis' of jelly. It is caused due to the following reasons:—

(i) Excess of acid breaks the jelly structure due to the hydrolysis and decomposition of pectin. It is generally noticed in tender jellies. It can be prevented by adding juices rich in pectin and low in acid, so that sugar may also be added proportionately to increase the volume and decrease the acidity to a greater extent, (ii) Less concentration of sugar also forces the net work of pectin to hold more liquid than it can retain and causes exudation, (iii) Insufficient pectin results in syneresis due to a weak net work of the pectin, which should be dense and rigid to hold the syrup properly, and (iv) The net work of the pectin also breaks due to premature gelation, while the jelly is being poured in containers and ultimately results in a weeping jelly.

Syneresis can be avoided by adding buffer salts like sodium citrate or disodium hydrogen citrate or common salt in small proportions.

For obtaining a good jelly, pectin, sugar, acid and water should be in proper proportions, otherwise the above-mentioned complications occur, and the whole process becomes a failure.

The above constituents should be approximately in the following proportions for proper setting of the jelly:

1. Pectin	... 1.0 per cent
2. Sugar	... 60-65 ,, ,,
3. Acid	... 1.1 ,, ,,
4. Water	... 33-38 ,, ,,

Fruits can be divided into four groups according to their pectin and acid content:

1. *Rich in pectin and acid*: Sour and crab apples, grapes (eastern), sour guavas, lemons, oranges (sour), plums (sour).

2. *Rich in pectin but low in acid*: Apples (low in acid varieties), unripe bananas, sour cherries, figs (unripe), pears, ripe guavas, peels of oranges and grape fruit.

3. *Low in pectin but proper in acid*: Apricots (sour), cherries (sweet vars.) sour peaches, pineapples and strawberries.

4. *Low in pectin and acid*: Ripe apricots, peaches (ripe), pomegranates, rasberries, strawberries and any type of over-ripe fruits.

PREPARATION OF MARMLADE

The principle of marmlade preparation is the same as for jelly excepting that the rind is also used for extraction of pectin which causes bitter taste to the product.

Selection of fruit: Take oranges and rough lemons in proportion of 2:1 and wash them properly.

Preparation of the fruit: Peel 30% of the oranges or maltas to be used and cut the slices into very fine shreds of about 1/20th of an inch with knife. Boil the shreds in water and go on changing the water until they become soft and lose the bitterness. Shreds prepared from red malta peels are known as "Golden shreds" and those prepared from yellow lemon peels are known as "Silver shreds". Peel the remaining fruits and leave the whitish spongy portion with the fruit because it contains pectin. Cut the fruits into thin slices and add about 3 times water and boil for about an hour, strain the juice through a thick cloth to discard the coarse pulp. A second extraction can be taken by boiling the residue for 10-15 minutes with a little water.

Mixing and cooking: Both the extractions are mixed and kept overnight for sedimentation. The clear juice is decanted next day.

*Pectin and acid content***:** The juice thus obtained should be tested for pectin and acid content as mentioned for jellies.

Addition of sugar: The sugar is added in proportion to its pectin content. (Equal amount for rich pectin extract and 2/3—3/4th the quantity of sugar in case of medium pectin).

Final cooking: Boil the juice till the temperature reaches 218°F and at this stage the shreds should be added. The boiling should be continued up to 212°F (100°C) or it gives sheet test as in the case of jelly.

Bottling and storage: Cool the marmlade and go on stirring so that the shreds are uniformly distributed. If it is filled hot the shreds float up and collect at the surface. Fill the finished product at about 150°F in sterilized bottles and cap tightly and store in a cool dry place.

CHAPTER 8

FRUIT PRESERVES

(MORABBA AND CANDY)

Those products in which the fruit retains its form and flavour with crispness when fully permeated with sugar syrup is termed as "Fruit Preserves". "Morabba" is that type of fruit preserve which is preserved in syrup as mango, aonla and apple morabba. "Candy" is that type of morabba of fruit preserve which is dry in look but fully permeated with syrup, e.g., Petha candy and Ginger candy.

Selection of fruit: The selected fruits should be fully developed, firm and slightly under-ripe. Unripe or fruits with loose pulp should be rejected.

Preparation of fruit: Wash the fruits thoroughly and remove the damaged portions, if any. Fruits of thin skins as in the case of berries are not peeled. Fruits like mangoes, apples, bel, petha possessing heavy skin must be peeled. Some fruits should be preserved, whole but bigger fruits are cut into large and good looking pieces or slices. Cores, seeds or stones should be removed. The slice should be kept in brine or water, otherwise the colour is changed to brown or black, and is known as "Browning of fruits".

Puncturing: The puncturing of the fruits or fruit slices should be uniform so that the sugar syrup may permeate properly. Excessive puncturing should be avoided as it softens the fruit too much.

Soaking: The punctured material (whole fruit or slices) are generally soaked in water, lime water, brine or alum solution before blanching and cooking. The duration varies from a few hours to a few days depending upon the texture (hardness or softness) of the fruit. The following are some of the advantages of soaking:

1. Hard fruits become porous and the syrup permeates properly during cooking, 2. Bitter and astringent fruits if soaked in 5% alum solution, lose the bitterness and astringency. The acidity of fruits higher in acid content is reduced if soaked in 5% salt solution, and 3. Soaking makes the fruits soft, the shrinkage is minimised and they are prevented from turning stiff.

Blanching: The soaked slices must be washed thoroughly with water. The washed slices are then wrapped in muslin cloth and given a dip in boiling water for 5-10 minutes according to their texure so that slices, pieces or fruits become more softer. This period should not be prolonged as the finished product becomes too soft and may lose the crispness.

Preparation of syrup: The quantity of sugar varies for various fruits, ranging from equal to double of the prepared fruits or slices. Make a syrup by boiling the sugar with 2-3 times of water and citric or tartaric acid at the rate of 3-4 g per kg of sugar is used so that the dirt of the sugar may come up on the surface and be removed with ease.

Cooking of fruits: The fruits or slices should be added to the syrup when it becomes thicker. The process should be carried on till the fruit slices are fully saturated with syrup which acquires a honey like consistency and when it is cooled and drawn between two fingers gives 3-4 threads, or syrup reaches the temperature of 224°-225°F or 101-101.5°C (at sea level). For every 500 feet rise in altitude the cooking temperature should be decreased by 1°F (0.5°C).

Always deep pans should be used for this purpose, otherwise in shallow pans the syrup becomes concentrated within a short time and the syrup fails to permeate the fruit.

While adding the slices or fruits in the boiling syrup, the consistency should not be too thick, otherwise a coating of the thick juice is formed. This prevents the juice to enter and the product becomes tough or shrivelled. It should also be taken into consideration that the fruits are well covered in the syrup otherwise the top pieces may dry and spoil the quality of product.

Bottling and storage: Cool the product and then transfer to sterilized wide mouthed glass bottles.

1. AONLA MORABBA

Select well ripe fruits free from wounds and bruises, wash thoroughly and puncture with a stainless steel fork or wooden pricks so that the fruits may not turn black. The puncturing should be quite uniform up to the stone. It must be kept into the mind that the fruits should not be over punctured, otherwise they crack while cooking. Soak in alum or line water for 3 days until they are free from astringency and bitterness. It is better if the water is changed after every 24 hours. The fruit can also be soaked in 2% brine. Wash the fruits thoroughly in water and boil until they are soft.

Method No. 1: Take one kg of sugar and 2 litres of water for 1 kg fruits. First take the sugar and water and mix by heating, add a little citric or tartaric acid and remove the scum and dirt, strain and boil again. After a few minutes add the fruits to the boiling syrup and cook it gently for 20-30 minutes and let the products stand overnight. Again start cooking until the syrup acquires a honey like consistency—cool the product and fill in wide mouthed bottles and cap tightly.

Method No. 2: Take equal quantity of sugar and aonla fruits (1 kg sugar for 1 kg fruits). Spread some sugar in a pan and arrange the pricked and boiled fruits on the layer of sugar and go on covering with the remaining sugar. Cover the pan and put it for 24 hours. During this period the water present in the fruit will dissolve the sugar. Take out the fruits and put the syrup obtained by this method for boiling and add 1 kg sugar and some citric acid to the hot syrup. Remove the scum and dirt and strain the syrup. Cook the aonla fruits in this syrup until it acquires a honey like consistency.

2. APPLE MORABBA

Take matured fruits of Kashmiri apples or Rhymer or No. 22 varieties as all the varieties are not suitable for the purpose. The fruits should be free from wounds and bruises, wash thoroughly and peel the fruits, cut into good looking pieces. Small fruits can be preserved as such. Keep the pieces in 2% brine or 3% alum solution for sometime, otherwise the slices will change their colour when they come in contact with the air. Puncture the pieces or fruits uniformly with a stainless steel knife or wooden prick. Now the fruits pieces or slices should be boiled in water for 5-7 minutes. Take the equal quantity of sugar considering the original weight of prepared fruit and finally proceed by any of the methods mentioned for 'Aonla'.

3. BAEL MORABBA

Select matured 'Bael' fruits when the pulp starts turning yellow. Cut the fruit with sharp knife or saw and make into small slices. Remove the rind and seed portion. Puncture the slices with fork and soak the prepared slices in lime water for about 3 hours, wash the slices 3-4 times and keep it in boiling water until it becomes soft. Take equal amount of sugar considering the weight of slices and prepare the morabba following the method No. 1 as mentioned for 'aonla'.

4. CARROT MORABBA

Scrape the thin peel and puncture with a fork, remove the leafy or green portion, if any. Soak them in water for about an hour and boil till the fruit becomes soft. Take equal amount of sugar and follow method No. 1 as for 'aonla'.

5. GINGER PRESERVE (MORABBA) AND CANDY

Select ripe, fibreless and good sized ginger knots. Wash thoroughly, scrape off the skin, prepare pieces of desired size and shape with a stainless steel knife and again wash and prick it with stainless steel fork or wooden prick. Put the pieces in boiling water and change the water 4-5 times so that the astringency is minimised and the pieces become soft. For one kg ginger pieces first take 0.5 kg sugar and 1 litre water. Prepare a syrup of sugar and water, add citric or tartaric acid to the boiling syrup and strain it. Take the ginger pieces and boil in this syrup for 30 minutes, remove the pan and allow it to stand for 24 hours. Next day take out the ginger pieces from the syrup and add 0.25 kg of sugar to the syrup, boil and strain. Boil the ginger pieces with this syrup for 15 minutes and allow it to stand again for 24-48 hours. Repeat this process for remaining 0.25 kg sugar and boil it till it attains honey like consistency even somewhat thicker than that. Cool the product and transfer to sterilized wide mouthed bottles.

Ginger Candy: If candy is to be prepared the above method should be followed and the preserve thus prepared is kept for 2-3 months for thorough penetration of sugar. Take the preserve (morabba) and boil for about 5 minutes. Take out the pieces and roll the pieces in finely ground sugar. Dry the pieces in shade on a wooden tray or at 120°F (47°C) in a drier till they lose stickiness when touched with the finger.

The syrup left after preparing candy can be used for preparing more ginger preserve or may be used in aerated drinks for providing ginger flavour.

6. MANGO MORABBA

Select well developed green mangoes, wash, peel and prepare good looking slices with a stainless steel knife. Prick the fruits properly and keep it for 5 minutes in boiling water by taking in a loose muslin bag. Take 1.5 kg sugar for 1 kg slices and follow method No. 1 as for 'aonla'.

7. PETHA MORABBA AND CANDY

Select fully ripened fruits which should be tough when touched with fingers. Wash thoroughly, cut longitudinally into 4 parts and remove the outer hard surface and skin carefully. Remove the internal spongy flesh near seeds. Prepare slices or cubes of desired shape and size and keep the pieces in 2% lime solution for 3-4 hours. Take out the pieces and wash them with cold water for 4-5 times so that the lime may be removed properly. Take the pieces in a loose muslin bag and dip it in boiling water for 5-10 minutes. By adding a little of alum the slices become more tough with whiteness. Take 1½ kg of sugar for 1 kg of slices and follow method No. 1 or 2 prescribed for 'aonla' for further preparation, but No. 2 is better. Kewra or rose water can be sprinkled or mixed with the syrup. If it is to be kept in dried form (candy), take out the pieces from the syrup after 4-5 days and dry them in shade.

8. PREPARATION OF BER CANDY

Select large-sized ber fruits and prick with a stainless steel fork or wooden prick. Place in 2 per cent brine. Raise the strength by 2 per cent every day till it reaches 8 per cent. Transfer to a fresh 8 per cent brine containing 0.2 per cent potassium metabisulphite and allow the mass to stand for 1 to 3 months. Take out the fruits, wash properly and boil till tender and prepare the candy like other fruits.

CHAPTER 9

CANNING AND BOTTLING OF FRUITS AND VEGETABLES

Canning of fruits and vegetables is based on the same principles and they are canned in the season when the raw material is quite cheap and available in plenty. The canned products are sold in off seasons with better returns and ultimately increase the net profit of the grower and varieties for the consumer.

Due to the marked change in the chemical composition of fruits and vegetables the canning of some of the vegetables differs from fruits, so both have beeen described separately.

A. CANNING OF FRUITS (including tomato)

1. **Essential equipments:** Large spoons, peeling and coring knives, aluminium or stainless steel pans of big size, sanitary cans of one lb. butter size or A $2\frac{1}{2}$ size, Farenheit thermometer graduated up to 240°F, Brix hydrometer, glass cylinder and can sealing machine.

2. **Selection of fruit:** The fruits should be matured and firm ripe, free from blemishes, diseases and bruises. Overripe fruits become very soft during sterilization process and the unripe ones are poor in flavour and colour. Tree ripened fresh fruits should be selected for the purpose from growing areas as most of the fruits available in the big markets, are picked immature or artificially ripened.

3. **Grading:** It is a very important aspect as the products prepared from graded fruits are always uniform and better. The fruits should be graded according to their variety, size, flavour, colour and maturity in different grades. The grading can be done in three general classes.

(a). *Fancy grade*: The fruits of best quality with full size, well developed flavour and colour and entirely free from blemishes and diseases come under this grade.

(b). *Standard grade*: This includes fruits of smaller size than the fancy grade, good in flavour and colour and reasonably free from belmishes.

(c). *Pie grade*: The fruits of small size, slightly over-ripe or blemished come under this grade.

4. **Sorting and washing:** Only desirable fruits as mentioned above should be selected for canning. The fruits should be washed thoroughly. They can be immersed in water for some time so that the adhering dirt may be properly removed.

5. **Peeling:** Some of the fruits do not require peeling but mostly the fruits are peeled by following methods before canning:

(i) **Hand-peeling:** This is done by hand with the help of a stainless steel peeling knife.

(ii) **Peeling by heat:** Fruits like tomatoes and peaches are kept in a loose muslin bag and are dipped in boiling water for a short duration and it results in loosening of the skin which can be very easily peeled by hand.

(iii) **Mechanical peeling:** Fruits of uniform shape as apples can be peeled by peeling machines.

(iv) **Lye peeling:** A 1.5 to 3 per cent sodium hydroxide (caustic soda) solution is prepared by dissolving sodium hydroxide in boiling water in an iron kettle and the prepared solution is known as 'Lye'. A single layer of fruits is spread on wire trays and are immersed in the boiling lye for 30-90 seconds. The treated fruits are dipped in cold water and are washed 2-3 times to remove the lye completely. Then the peels are removed by brush or hand. The fruits peeled by this method require less cost and the time is also minimised.

Apricots, peaches and sweet potatoes are generally peeled by this method.

(v) **Brine peeling:** A saturated solution of common salt is maintained at its boiling point. The material which is to be peeled is immersed for desired time and the softened skin is removed by water jets of high pressure. It is better than lye-peeling in the sense that the cost of preparation of the solution is cheaper. No special care is to be taken in this type of peeling and if some salt goes with the products it is immaterial.

6. **Slicing, coring and pitting:** Fruits may be cut into halves or slices of convenient size. Stone, seed and cores should be removed. Some of the fruits like plum from which the seeds cannot be taken out easily are canned whole.

7. **Filling and syruping:** Take previously washed and sterilized cans and pack the desired weight of slices or fruits properly. In one lb. butter size can the quantity of slices should be 230-285 g and in 27A size it should be 510-565 g. Pour strained hot sugar syrup which is used in different concentration for various fruits ranging from 20-55°Brix. Fruits rich in acid require more concentrated syrups than other ones. The syrup should be filled leaving a head space of 1-2 cm.

The proportion between the quantity of sugar and water for different concentrations is presented in the under mentioned table:—

Water (*l*)	*Sugar* (*kg*)	*Strength of the syrup* (%)
1	0.250	20
1	0.333	25
1	0.428	30
1	0.538	35
1	0.666	40

1	0.818	45
1	1.000	50
1	1.222	55

(1 litre of water = 1 kg water by weight).

For general use, sugar and water can be taken as below and the syrup can be termed as light, medium and heavy considering the strength.

Water (l)	*Sugar (kg)*	*Syrup strength*
2.0	1	light
1.5	1	medium
1.0	1	heavy

8. **Exhausting:** The preliminary heat treatment given to the filled can is known as 'exhausting'. This helps in driving out the air present in the fruit tissues and so prevents the product from discolouration and retains flavour during storage. The open filled cans are placed in a large vessel with boiling water 4-5 cm below the tops of the cans. Cover the vessel and boil till the temperature reaches 180°-205°F (82-102°C) and the centre of the can records a temperature of 160°-170°F (71-77°C). This process should be done for 6-10 minutes.

9. **Sealing:** Immediately after finishing the process of exhausting seal the cans air-tight by means of a can sealer. The cans should be marked by a glass marking pencil or waterproof ink to avoid mixing.

10. **Sterilization or Processing:** It is a very important process in canning. The sealed cans are immersed in boiling water at 212°F (100°C), keeping the level of water 2.5-5.0 cm over the tops of the cans. The cans are sterilized for 10-30 minutes for different fruits as presented in the undergiven table. Under and over sterilization (processing) causes severe damage to the products which has been dealt in detail in

Chapter III. The period of sterilization should be calculated after the water first boils.

S. No.	Fruit	Preparation of fruit	Strength of syrup (%)	Period of sterilization in mts at 212°F (100°C)	
				1 Pound (butter can)	A-2½ can
1.	Apricot	Can whole or halves	50	25	30
2.	Grapes	Remove stem of individual berries	35	12	15
3.	Grape fruit	Put fruits in hot water at 200°F (93°C) for 3-5 mts. remove skin and fill individual peeled segment	50	20	25
4.	Guava	Peel, cut into good looking pieces, remove all seedy portion, treat with 2% brine and wash before filling	40	25	30
5.	Litchi	Peel by hand and remove the pits	40	25	30
6.	Mango	Peel, cut into good looking slices	35	12	15
7.	Papaya	Peel, cut into good looking slices, discard seeds.	40	35	40
8.	Peaches	Soften by putting in boiling water, cool quickly in cold water,			

	remove skin, halve, pit and slice before filling.	45	30	35
9. Pears	Peel, halve, remove cores.	40	25	30
10. Pineapples	Peel, cut into 1 cm slices, remove core and eyes.	45	12	15
11. Plums	Prick the fruits	40	15	20
12. Strawberry	Stun, add 0.25 kg sugar per 2 kg fruit (1 : 8), slowly boil, keep overnight, boil quickly before packing.	50	12	15
13. Tomatoes	Take in loose muslin bag, dip in boiling water for 1/2-1 mt., then quickly in cool water Skin is loosened, remove green portions and stem, if present.	(Note No. 3)*	50	55

Note. 1. The kind of cans used for the above fruits should be plain except plums and strawberries for which lacquered cans are used. Mango may also preferably be canned in lacquered cans.

2. Due to sweetness of mango and papaya fruits, 1.5 g. citric acid can be added per kg. of syrup with advantage.

*3. In tomatoes, add common salt 1/2 teaspoon per kg and slightly less than 1/2 teaspoon sugar in one pound butter can and 2½ teaspoonful of common salt and 2 teaspoonful of sugar in A-2½ size can. Fill with boiling tomato juice or strained hot water while peeling.

11. **Cooling and storage:** The cans should be cooled rapidly by dipping them preferably in running water. Take out the cans then slightly warm and dry in air. Label the cans and store in a cool dry place. If the cans are to be stored for a longer time they can be labelled just before despatch in an attractive manner.

BOTTLING OF FRUITS

Bottles prove to be very good containers for home preservation of fruits. Although the initial cost is more but they can be used several times and last for many years if carefully handled. The fruits give an attractive look through the glass and are prevented from developing metallic flavour. In this process there is no necessity of can sealing machine. Considering the manufacturer's side, it is not suitable for them due to higher initial capital. The cans are cheaper, quite handy and lighter in transport with a minimum loss due to breakage. Hence on commercial scale tin cans are preferred over glass jars or bottles.

There are many types of glass containers having different shapes and sizes with various methods of hermetic seals. The jars fitted with wire clamps are supposed to be the best. The products remain in most sanitary conditions because they do not come in the contact of rubber or metal.

Essential equipments, selection of the fruit, grading, sorting and washing, peeling, slicing and coring are the same as followed for canning of fruits.

Filling and syruping: The bottles should be thoroughly washed and sterilised for 15 minutes. Fill the slices in an attractive manner leaving 1½-2½ cm space on top of the jar or bottle. Prepare the sugar syrup recommended for different fruits and fill the boiling hot syrup in the jars leaving a head space of 1-1½ cm at the top.

Exhausting and sterilization: Separate exhuasting is not required in bottles and is done simultaneously with sterilization putting a pad of cloths (false bottom) under the bottles. The bottles should not be abruptly immersed in the hot water, otherwise they may break due to sudden temperature. The temperature of the water should be about to that of the contents and should be raised gradually and the bottles must remain in the boiling water for the desired time. In the beginning of the sterilization the lids are left loose and the boiling water is kept up to the neck of the bottle but in the end the bottles or jars should be immediately clamped or corked tightly.

Cooling and storage: As for canning of fruits. But the products preserved in bottles require more attractive labels.

B. CANNING AND BOTTLING OF VEGETABLES

1. **Essential equipments:** A pressure cooker (autoclave, retort or sterilizer) is necessary in addition to other equipments mentioned for the canning of fruits.

2. **Selection of raw material:** The material selected should be fresh, matured, uniform, slightly tender and free from blemishes, rots and diseases. It is better to locate the cannery near fields producing vegetables of the above mentioned qualities.

3. **Sorting and Washing:** The raw material should be graded and sorted as given above and the undesirable material should be rejected. Vegetables require thorough washing as they contain more soil particles and micro-organisms than fruits due to their direct contact and nearness to the soil.

4. **Peeling, slicing and shelling:** The vegetables should be peeled, sliced or shelled according to their nature as peas are shelled, carrots are scrapped, beans are snipped or trimmed.

5. **Blanching:** It is also termed as "parboiling", "precooking" or "scaling". The vegetables are taken into a loose bag of muslin and dipped in boiling water for 2-5 minutes with the following advantages:—

1. The objectionable flavours and adhering soil particles are thoroughly removed.

2. The colour and texture is improved.

3. The skin of vegetables such as carrots, sweet potatoes are loosened and thus help in peeling.

4. The vegetables are softened and large amount of them can be easily packed in a can.

5. The brine remains clear due to this process.

For keeping the vegetables in good condition, overcooking should be avoided and a dip in cold water should be given immediately.

6. **Packing and brining:** The vegetables should be packed properly in the sterilized bottles or glass jars or cans after blanching and they should contain the minimum weight of vegetable specified as under:—

For 1 lb. butter size cans drained weight–269.0-283.0 g
For A 2½ ,, ,, ,, ,, ,, –538.0-566.0 ,,
For pint glass jars ,, ,, ,, –283.0-311.0 ,,

The liquid which is used to fill a canned product is known as "covering liquid". Hot brine of 2-3% concentration is used as a covering liquid for vegetables and it is filled leaving a space of 0.75-1.25 cm at the top. The brine should be properly filtered with a thick cloth before filling.

Water (l)	*Salt (g)*	*Strength af brine (%)*
1	10.00	1
1	20.40	2
1	30.92	3
1	41.66	4
1	47.33	5
1	111.11	10
1	176.47	15

7. **Exhausting:** It is the same as described for fruit canning. The cans can be exhausted for 4-6 minutes at a temperature of 200°F and 6-10 minutes at 170°-180°F. However, the time will vary with the nature of the packed material.

8. **Sealing of bottles:** The same as for fruits. The lids of the glass jars must have rubber rings in between the mouth of the jar and so that it may be sealed air-tight.

9. **Sterilization or Processing:** The canned vegetables are sterilized for a longer time and at a higher temperature when compared with fruits due to the following reasons:—

1. Vegetables are generally in close contact of the soil and are contaminated with resistant soil borne organisms.

2. More cooking is required which develops the flavour and texture in the case of vegetables.

3. Mostly all the vegetables are non-acidic and may possess spore bearing bacteria which are resistant to boiling water and are destroyed by prolonged higher temperature.

Usually the vegetables in sealed cans are sterilized at 240°F (10 lb pressure) in the pressure cooker for 25-90 minutes. Generally water boils at 212°F but higher temperatures can be attained with the help of a pressure cooker. About 7-8 cm of hot water is added to the pressure cooker and the sealed cans arranged on crates are placed into the cooker. The cooker is screwed tightly with its cover and the petcock open is heated. The steam cock should be closed when the steam starts coming out freely and the heating should be continued till the pressure gauge shows the desired temperature. When the desired temperature reaches that is supposed to be the starting time of sterilization. After heating up to the required time the cooker should be removed from the fire and the petcock is opened. When the pressure comes to zero the cover is removed and the cans are taken out. The excess of steam is released through the safety valve but sometimes this value becomes corroded or chocked, hence it should be checked specially at high pressure.

The time of sterilization depends upon the kind of vegetable, stage of maturity, size of the container and density of the pack. The duration for sterilization for important vegetables have been presented in the undergiven table:

Sl. No.	Name of vegetable	Preparation before canning	Period of sterilization in minutes at 240°F (10 lb. pressure)		
			Can A2	Can A2½	Glass jars (pint)
1.	Beans	Shell, grade, boil for 5-10 mts., loose packing.	30	30	35
2.	Beets*	Wash, steam boil 15 mts., add salt, pack.	30	30	35
3.	Cabbage	Wash, boil 10 mts., add salt, pack.	40	45	45
4.	Carrots	Wash, scrape, boil 5 mts., pack.	30	30	35
5.	Cauliflower	Soak in cold brine, boil 3 mts., and salt, pack.	25	25	30

6. Okra (Bhindi)	Wash, remove cap, boil 3 mts., pack.	20	25	25
7. Peas	Shell, grade, boil 3-5 mts., peel, pack.	40	45	45
8. Potatoes	Peel, blanch for 3 mts., pack.	35	40	40
9. Pumpkin*	Wash, cut into pieces, cook until tender, mash, pack.	70	95	75
10. Spinach and other greens	Steam in covered vessel for 15 mts., use little water, loosely pack.	50	55	55
11. Sweet potatoes	Wash, boil or steam 15 mts., peel, pack.	115	145	120
12. Turnips	Peel, slice, blanch and pack.	30	30	35

*Lacquered cans should be used, for others ordinary plain cans.

10. **Cooling and storage:** As for canned fruits.

CANNING OF CURRIED VEGETABLES

The selected vegetables should be mature, tender, free from blemishes and diseases. Grade the vegetables properly and remove the non-edible portions, wash them thoroughly.

Preparation of vegetable: Prepare the vegetable according to its nature, e g., remove the outer hard leaves of cabbage, remove the leaves of cauliflower before cutting it into small florets, shell the peas, peel the root vegetables and cut into convenient pieces or slices.

Take the spices in the undergiven proportion and prepare the curried vegetables, as in our common home. It should be taken into mind that the quantity of water taken should be less and the vegetables should not be tender after preparation.

Vegetable	*1 kg.*
Turmeric (powdered)	10.0 g
Red chillies (powdered)	10.0 ,,
Ghee or butter	160.0 ,,
Garlic (finely chopped)	20.0 ,,
Onion (finely chopped)	400.0 ,,
Salt (powdered)	60.0 ,,
Tomato	350.0 ,,
Ginger (finely chopped)	10.0 ,,
Cardamon (major)	2.75 ,,
Cumin seed (powdered)	5.25 ,,
Coriander (powdered)	10.0 ,,

Filling, exhausting and sealing: Put the hot curried vegetables in cans, fill with 2% brine. Exhaust the cans for 10 minutes (or when the temperature of central portion reaches 170°-180°F or 77-82°C). Seal immediately as mentioned before.

Processing: Put the sealed cans in a pressure cooker at 240°F (i.e., 10 lb. steam pressure) for 40-75 minutes depending upon the size of container, kind and maturity of vegetables, quality of fat etc.

Cooling and storage: After removing the cans from the pressure cooker, place them immediately under running water till the cans become fairly cool, wipe off, dry and finally store them in a cool dry place.

GENERAL CONSIDERATIONS IN ESTABLISHING A COMMERCIAL FRUIT AND VEGETABLE CANNERY

The following are the main factors which must be considered before establishing a commercial cannery:

1. Availability of raw materials.
2. Site and building.
3. Availability of labour.
4. Duration of canning season.
5. Water supply.
6. Disposal of cannery wastes.
7. Transport facilities.

1. Availability of Raw Materials

This factor is second to none in importance, while considering to start a commercial cannery. The raw material available should be of a very high quality. Some fruits and vegetables are quite good for the fresh market but are not suitable for canning. So they should possess their top merit for preservation which has been described before in detail while dealing individual products.

The consideration of price of raw materials is also one of the main problems which affects the cost of the finished products. In India the cost of fruits and vegetables is too high in the beginning but it becomes cheaper in the season of gluts and at that time plenty of suitable raw material of excellent quality can be purchased at a low cost. In America and U.K., the canners grow their own crop of fruits and vegetables or they supply quality seeds to the prospective growers and contract them to take the whole crop.

In our country there are fluctuations in the supply of raw materials due to different seasons of the maturity of fruit and vegetable crops. Hence to ensure a proper functioning of the cannery, there should be some alternative products which can be prepared in periods of gap.

2. Site and building

The site for a cannery dealing with fruits and vegetables should be in the vicinity of the growing areas so that the time of picking, packing and transport may be minimised with an excellent quality of available raw materials.

The site selected should not be deficient in water supply. Space is also important so that overcrowding may be avoided and there may be a further scope of extension. Such sites having factories which emit objectionable fumes and ultimately contaminate the air are not suitable for starting a cannery.

After selecting a good site the question of building is also important. Old and existing buildings are not suitable for the purpose. The plan should be designed properly which directly influence the efficiency of the factory.

In our Indian conditions, single storied structures are suitable for the purpose. It also depends upon the working space, cost of the land etc. The single storied buildings are always preferable as all the equipments and heavy machinery can be erected without difficulty and can be interchanged with ease at any time of necessity. The ventilation and light facilities are also good in single storied buildings and it is also easily manageable. Although no hard and fast rule can be laid down but generally fruit and vegetable canneries are single storied.

The space covered by any part of the cannery depends upon the type of product to be packed and scale of operation. The canneries which are mainly of seasonal nature should provide good room for different products. However, the division of space may be done considering the following steps of canning process:—

(i) Receiving and storage section.
(ii) Preparation section.
(iii) Filling, exhausting, sealing and processing section.
(iv) Finishing section.
(v) Laboratory section.

(i) The area for receiving and storage section can be fixed according to the nature of the raw materials. The receiving area should be nearer to the rail and road speclally where perishable products are dealt with.

(ii) The preparation section in fruit and vegetable canneries requires a greater area when compared with other products. The section should also be well sanitated so that the risk of spoilage may be checked. The preparation rooms should be fitted with proper water and steam lines so that the spreading of hoses while washing may be avoided. As far as possible the floors should be (a) resistant to chemicals, (b) resistant to wear, (c) slip proof, (d) easy placed drains, (e) with proper slope and (f) provided with clean and well placed drains. The preparation area can also be sub-divided into different compartments such as washing, peeling or shelling, extraction of juice etc.

(iii) Proper care should be taken to control the humidity in the processing section where mostly exhausting and sterilizing operations are taken up. The floor should also be quite sturdy to stand the heavy traffic on it.

(iv) The finishing section in which incubation, lacquering, labelling, casing are carried on should be scrupulously clean, cool and dry with nice ventilation.

(v) Apart from the above sections, a laboratory, however, is expensive but it is a very important organ of a cannery and it can take care of (a) Examination of raw materials, (b) Control of processes, (c) Examination of finished products, (d) Introduction of new processes and products, (e) Introduction and implimentation of new techniques which are of importance to the industry.

Apart from the above sections there should be a proper room for storing the cans, waste products, machineries and other equipments.

3. Availability of labour

The problem of labour is not so acute in India in comparison to western countries as discussed in Chapter II. The number depends upon the size of the cannery, type of products and degree of mechanisation. But the labourers engaged in this work should be trained ones and should possess a sound knowledge. Ladies can also be engaged with success but their training is essential before they start working.

4. Duration of canning season

In fruit and vegetable canning seasonal fluctuations are bound to occur. If the gaps are not filled with proper non-seasonal products, the cost of production goes up and results a collosal loss to the industry. Hence for reducing the cost of production, proper substitutes should be included in the off-season programmes.

5. Water supply

Water plays an important role specially in the canning of fruits and vegetables. It is used in substantial quantities for (a) cleaning of equipments, floors, walls, etc., (b) washing and preparation of raw materials, (c) preparation of brine, syrups etc., (d) blanching, (e) cooling and processed cans, (f) steam generation.

The water to be used in the cannery should be free from contamination. It can be clorinated after securing the advice of water treatment technicians.

6. Disposal of cannery wastes

A large volume of wastes is produced from a fruit and vegetable cannery containing a high percentage of solid matter, such as skins, peels and coloidal starchy materials. Hence the cannery should be situated at such a place that these wastes may also be utilized properly and may fetch some money.

7. Transport facilities

The problem of transport under Indian conditions has been dealt in Chapter II and it requires no special emphasis at this place. However, this is of paramount consideration that the cannery should be situated nearest to road which connects important places of that area.

CHAPTER 10

DRYING AND DEHYDRATION OF FRUITS AND VEGETABLES

The art of drying of food-stuffs specially of fruits and vegetables is very old and in modern times it is being done on improved scientific lines.

Both the terms 'drying' or 'dehydration' mean the removal of water. The products which are generally dried in the sun for them the word "dried" is used. Those which are dried by artificial heat come under dehydration.

Dried, dehydrated or evaporated fruits and vegetables are advantageous when compared with other methods of preservation.

1. Dried products are less in weight and reduce to 1/4th to 1/9th from their original weight thus reduce the cost in transport.
2. Due to the reduction in bulk the product requires less space while storage.
3. The cost of production of dried fruits is also very low, due to less labour and no sugar, when compared with canned foods and other products.

In the process of drying or dehydration, sufficient moisture is removed and thus the product is ensured against spoilage. This process should be done in such a way that the food value, natural flavour and characteristic cooking quality of the raw material may be retained after drying. Hence, it is advisable that the process should be taken up with utmost care as specified below:

For small quantities of fruits and vegetables the drying can be done in the sun. An aluminium pan, few peeling and slicing knives and a clean board will serve the purpose while sun-drying.

A drier or dehydrator and a sulphuring box will be required in addition to the above equipments for larger quantities. Dehydrator is a box of 3 × 2 × 3 ft dimensions and made of strong galvanised iron sheet. The bottom is prepared from a perforated iron sheet to allow hot air to come in and the sides are enclosed in a wooden frame work. This box is supported on an iron stand 1¼′ high. A coal hearth or kerosene oil stove can be placed below the perforated bottom as a source of heat. The moisture is let off through two slits of 2 ft × 1.5 inches (60 × 3.75 cm) which have been provided on both the sides below 4 inches of the top. These slits are covered with collapsible metallic flaps and thus the flow of air can be regulated by opening and closing the slits. The drier mentioned above can accommodate 7 trays of 2¾ × 2 ft (83 × 60 cm) size.

PROCESS OF DEHYDRATION

1. **Selection of raw material:** Select matured and sound fruits of first grade quality. The selected vegetables should be sound, tender, free from bruises and diseases. Grade the fruits and vegetables according to the size, maturity and colour.

2. **Preparation:** Wash the raw material properly and prepare in the same way as specified for canning of different fruits and vegetables.

3. **Blanching:** All the vegetables require this treatment as mentioned in the chapter of Canning of Vegetables, while fruits require no blanching.

4. **Chilling:** Just after blanching the vegetables should be immediately dipped in cold water, that is why this process is termed as "chilling".

5. **Sulphuring:** Sulphur dioxide fumes act as disinfectant for the fruits and prevent the oxidation and darkening due to exposure. This occurrence is generally noticed in the sliced fruits which darken due to oxidation of the colouring matter when exposed for sometime. Sulphur fumes also act as preservative and check the growth of moulds etc., and prevent the cut fruit pieces from fermentation, while drying in the sun which is a somewhat slow process. Vitamins are also protected by sulphur fumes, while unsulphured ones lose their vitamin content. Vegetables are not generally sulphured and it is mostly used in the case of fruits.

The whole fruits, slices or pieces are exposed to the fumes of burning sulphur inside a closed chamber known as "sulphuring box" for 30-60 minutes.

'Sulphur box' is a closed air-tight cup-board like chamber of galvanized iron sheet. It is fitted in a wooden frame work having runways on both sides to hold the trays. For small scale works a size of 3′×2′ × 3′ (0.9 × 0.6 × 0.9 m) is convenient which can hold 11 trays each of about 2′-9″ × 1′-11″ dimension. The sulphur box holding 10 trays will require burning of about 3 g of sulphur for one charge.

6. **Drying or dehydration :**

Drying: If the fruits or vegetables are to be sun-dried the fruits, vegetables or their pieces should be thinly and evenly spread on the trays or boards and must be exposed to the full sun.

Dehydration: While drying the fruits or vegetables by this method a thin layer of the fruits, vegetables or their pieces or slices should be spread on the trays and should be pushed inside the dehydrator and the door is closed. The temperature of the dehydrator is increased to 110°F (43°C) and is gradually increased to 140-150°F (60-66°C) in the case of vegetables and 150-160°F (66-71°C) in the case of fruits.

The examination of the trays at proper intervals is essential, if necessary the pieces can be stirred by fingers to encourage an even drying. The fruits can be considered dry when they leave no signs of moisture or stickiness when gripped firmly in the hand. The vegetables can be considered dry when they become brittle. At this stage, the fruits and vegetables should be removed from the dehydrator. The moisture content in the case of vegetables should be not more than 6-8 per cent and in the case of fruits it should be about 20-24 per cent.

7. **Packing and storage:** The dehydrated or dried fruits and vegetables should be packed in air-tight tins. They can also be packed in paper cartons made of thick and heavy paper. The store should be warm and dry for the storage of dried fruits and vegetables.

8. **Directions before use:** The dried fruits can be used as such or after soaking.

Vegetables—Soak the dried vegetables overnight and cook in the same water so that the dissolved mineral salts may be utilized. For every cup of dried fruit use 3 cups of water.

Advantages of dehydration over sun-drying

1. The process of dehydration is much more rapid than sun-drying.

2. Less land and few trays are required.

3. Dehydrated fruits are produced under most sanitary conditions.

4. Sun-drying is not possible in rains while weather conditions have no effect on drying by dehydration.

5. The colour of dehydrated fruits or vegetables is uniform due to less variations in temperature.

Directions for dehydration of different fruits and vegetables

Name	Preparation of raw material	lb per sq ft of tray	Sulphuring or blanching of tray	Safe finishing temp.
A–Fruits				
1. Apples	Peel, core, slice or cube	2	Sulphur 30 mts.	165°F
2. Bananas	Peel, halve lengthwise or slice crosswise	1–2	Sulphur 30 mts.	160°F
3. Dates	Wash, give a dip in boiling 1/2% caustic soda solution	2	—	140°F
4. Figs	Wash properly	2–3	Sulphur only Adriatic var. 1 hour	150°F
5. Grapes (muscat & wine vars)	Dip in boiling 2½% lye solution, then rinse properly.	3	Sulphur 60 mts	150°F
B–Vegetables				
1. Cabbage	Shred, blanch 2 mts in sod.-bicarbonate solution, rinse properly.	1–2	—	150°F
2. Carrots	Peel and cube	2	Blanch in steam for 5 mts	150°F

Name	Preparation of raw material	lb per sq ft of tray	Sulphuring or blanching of tray	Safe finishing temp.
3. Onion	Peel, slice 0.25 cm thick, dip in cold brine 3%	1	—	140°F
4. Peas	As for canning	1–2	Steam blanching (optional)	150°F
5. Potatoes	Peel, slice or cube, dip in boiling water for 2 mts.	1–2	,,	150°F
6. Tomatoes	Slice 1 cm thick or peel and halve	1–2	Sulphur 30 mts (optional)	150°F

CHAPTER 11

PICKLES AND CHUTNEYS

Pickling with the help of vinegar and oils has been in practice from time immemorial in this country. If these preservatives are used in proper proportions the pickles can be retained for 10-15 years without spoilage. In modern days pickles are prepared with 1. Salt, 2. Oil, 3. Vinegar, 4. Mixture of salt, oil vinegar and spices.

1. **Salt**

Salt is used in the concentration of 15% or above of the slices or prepared raw material, lime and mango pickles are nice preparations prepared by the help of salt.

(a) *Lime pickle*

Select sound, fully matured juicy and deep yellow lime fruits. Halve the fruits and put half of them in a jar and extract the juice of the other half of the fruits. Add the extracted peels to the halves and take 15% well powdered salt by weight of the original quantity of fruits and add the lime juice and the salt to the halves. Put the ingredients in the sun for 4-6 days and shake the jars daily at least twice. Now green chillies, ginger and black pepper can be added according to the taste and the pickle becomes ready for storage.

(b) *Mango pickle*

Select matured green mangoes, wash and peel. Cut the slices of the fruits. Put the slices in a jar or earthen pot. Take 15% of well powdered salt on the basis of the weight of the slices, sprinkle it on the slices and put it in the sun for a week. Shake the jar or pot daily at least twice, to mix the salt properly. Black pepper can be added according to the taste.

2. Oil

While preserving the pickle in oils, it should be taken into mind that the whole portion of the pickles should be fully immersed in the mustard oil.

Mango pickle in oil :

Method of preparation: Take well matured green mango fruits, wash and cut the fruits into four longitudinal pieces. Take out the stone cautiously and take the undergiven spices, grind them and paste them on the mango slices by mixing with mustard oil.

(i)	Mango slices	1 kg
(ii)	Salt	64 g
(iii)	Red chillies	18.92 g
(iv)	Turmeric	25.52 g
(v)	Coriander	37.84 g
(vi)	Fenugreek (whole)	6.42 g
(vii)	Aniseed	12.76 g
(viii)	Nigella	12.76 g
(ix)	Mustard or rape	12.76 g

Roast the fenugreek, aniseed and nigella in dry form in a pan. Grind the rape seeds coarsely and mix the salt and all the ingredients in the oil and apply on the mango slices. Keep the slices in a jar and fill it with sufficient mustard oil to keep the surface covered.

If the quantity of salt mentioned in the above recipe is increased 2·3 times the pickle can be preserved without additional mustard oil.

3. Vinegar

A number of fruits and vegetables are preserved in vinegar, e.g., mango, jamun, garlic, chillies etc. The vinegar in which these things are preserved should contain good percentage of acetic acid. These can also be preserved in 5% acetic acid solution.

4. Pickles prepared from the mixture of salt, oil, vinegar and spices :

(a) *Sweet turnip pickle*

Take sound and tender turnips of good quality and wash with water. Chop off the inedible portions, peel the rough and thick skin and cut it into 1/2-1 cm thick round slices and follow the following recipe:

(i)	Turnip slices	1 kg
(ii)	Mustard	51 g
(iii)	Blak pepper	12 g
(iv)	Red chillies	24 g
(v)	Dried dates	24 g
(vi)	Garlic (chopped)	12 g
(vii)	Onion (,,)	102 g
(viii)	Ginger	24.0 g
(ix)	Salt (powdered)	102 g
(x)	Vinegar	81.5 ml
(xi)	Gur	64 g
(xii)	Mustard oil	102 ml
(xiii)	Tamarind	24 g
(xiv)	Cinnamon and caraway	7 g

Fry the chopped onion, garlic and ginger in a small quantity of oil. Soak the tamarind overnight, extract the thick pulp and discard the seeds, stems etc. Cut the dried dates into small pieces. Mix all the above ingredients except 'Gur' in the mustard oil and pack the mixture in a glass or glazed container. Put it in the sun for 4-5 days till it develops pickle flavour. Prepare a thick syrup of gur and mix it to the pickle and put in the sun for next 2-3 days. Finally add all previously heated and cooled mustard oil and keep the pickle in the sun for another 3-4 days till the slices become soft and attain the flavour and aroma of pickle.

Red chilli pickle:

Select matured good sized red chillies. Remove the stem and take out the seeds by the help of a small bamboo needle. Mix the seeds with the following spices. Take the spices and mix in a small quantity of oil. Fill the spices properly in the shelled chillies, pack it in the jar and put in the sun for 3-4 days.

(i)	Red chillies	1 kg
(ii)	Salt	128 g
(iii)	Cumin seed	3.3 g
(iv)	Nigella	1.6 g
(v)	Clove	3.3 g
(vi)	Cardamom major	1.6 g
(vii)	Cinnamon	3.3 g
(viii)	Mustard	33.0 g
(ix)	Amchur	257.0 g
(x)	Mustard oil	257.0 ml

'Madar' leaf pickle :

The pickle prepared from 'Madar' (Calotrapis procera) leaves has got a very good medicinal value. It is very much beneficial in stomach disorders.

Take half ripened madar leaves and boil it in water for 15 minutes. Take out the leaves, wipe off the water and follow the following recipe:

(i)	Madar leaves ...	1 kg
(ii)	Fennel ...	0.25 kg
(iii)	Coriander ...	0.25 kg
(iv)	Dry ginger ...	0.25 kg
(v)	Asafoetida ...	25.3 g
(vi)	Cardamom major ...	25.3 g
(vii)	White cumin seed ...	50.0 g
(viii)	Black cumin seed ...	50.0 g

(ix)	Cinnamon	75.0 g
(x)	Black pepper	66.0 g
(xi)	Pipal	66.0 g
(xii)	Clove	15.0 g
(xiii)	Dried mint leaves	66.0 g
(xiv)	Nutmeg (Jaiphal)	66.0 g
(xv)	Mace	13.0 g
(xvi)	Salt (Black)	0.25 kg
(xvii)	Salt (Jawahar)	13 0 g
(xviii)	Salt (Sendha)	66.0 g

Take the above ingredients (from ii to xviii), powder them, sprinkle evenly on the madar leaves and put it in a jar and keep it in the sun. Next day take 1 lb. for I or 1 kg for II lime juice, add to the jar and put it in the sun for the next seven days.

CHUTNEY

Chutney is preserved with the help of sugar and salt. Mango, apple, tomato etc., are the most suitable fruits for preparing chutney.

(i) *Sweet Mango chutney*

Select unripe and firm but fully developed fruits with yellow pulp. Peel the outer green skin with a stainless steel knife and grate the peeled fruits on a grater into fine shreds. The following is the recipe :

(i)	Slice or shreds	1 kg
(ii)	Gur or sugar	1 kg
(iii)	Salt (powdered)	46 0 g
(iv)	Onions (chopped)	61.5 g
(v)	Garlic (chopped)	15.5 g
(vi)	Ginger (chopped)	15.5 g
(vii)	Red chillies (powdered)	15.5 g
(viii)	Black pepper, cardamom	

	major, cinnamon, cumin seed, aniseed	33.0 g
(ix)	Vinegar (good quality)	165.0 ml

Warm the slices or shreds in a little water to make them slightly soft. Sprinkle the salt and sugar on the shreds and mix it properly and put it for about an hour so that the added sugar and salt may be dissolved in the extracted juice from fruit. Put the mixture on a low flame and the spices etc. (iv-viii) should be chopped and coarsely powdered and tied loosely in a small muslin bag. The bag is put with the shreds and is heated with occasional stirring till the mixture becomes sufficiently thick. Then the muslin bag is removed and it is squeezed to extract the flavour and aroma of the spices. At this stage the vinegar is also added to the product and the heating is continued till the mixture reaches the desired consistency. Cool the product a little and then pour into clear and previously sterilized wide-mouthed bottles and cap tightly.

(ii) *Apple chutney*

Take some apples and peel it. Remove the cores and seeds and cut into small slices or pieces and follow the following recipe :—

(i)	Apple slices	1 kg
(ii)	Sugar	0.75 kg
(iii)	Salt (powdered)	45 5 g
(iv)	Dried dates (chopped)	125.0 g
(v)	Raisins	62.5 g
(vi)	Ginger (chopped)	62.5 g
(vii)	Red chillies (powdered)	16.5 g
(viii)	Black pepper, cardamom major, cinnamon, cumin seed, aniseed (powdered)	13.5 g
(ix)	Onion (chopped)	333.6 g

(x) Garlic (chopped)	...	11.0 g
(xi) Vinegar	...	2.55 ml

Except sugar and vinegar mix all the ingredients and heat for 5 minutes with a small quantity of water so that the mixture may become soft. Add the sugar and vinegar and heat till it reaches the desired consistency. Cool the product and pour into clean and sterilized wide mouthed bottles and cap tightly.

CHAPTER 12

PRODUCTS PREPARED FROM DIFFERENT FRUITS

I. APPLE PRODUCTS

Apple is one of the most nutritious fruits of the world and requires no introduction. The following are the fruit products which can be prepared from apple fruits :—

1. Apple chutney
2. Apple cider
3. Apple juice
4. Apple morabba

1. Apple chutney

For details see page 101.

2. Apple cider

For details see page 48.

3. Apple juice

Apple juice is very popular in western countries and this unfermented drink is becoming quite popular in India as well. Yellow Newton and Baldwin varieties of Kulu valley are very suitable for the purpose.

Wash the fruits thoroughly with a weak hydrochloric acid (5 litre acid in 100 litres water) to remove the spray residues. Make pieces of 0.3-1.25 cm and remove the cores and seeds with a stainless steel knife or apple grater. The juice can be taken out by pressing into a basket press and kept in an aluminium or stainless steel pan. Strain the juice through a coarse muslin cloth to obtain uniform juice. The juice is then heated to 180-185°F (82-85°C) temperature, filled in clean and previously sterilized bottle and heated in boiling water for 10-15 minutes till it overflows from the bottle. Immediately cork the bottles with previously boiled crown corks. Pasteurize the bottles by putting on the false bottom at 175°F (79°C) for 30 minutes. Cool the bottles and store in a cool dry place.

II. BANANA PRODUCTS

The following are the fruit products which can be prepared from banana fruits :

1. Canned ripe banana
2. Dehydrated ripe banana
3. Banana chips

1. Canned ripe banana:

Select fully ripe and firm fruits with proper aroma and flavour. Peel the fruits and cut into 1.25-2.0 cm slices with a stainless steel knife. Prepare 25-30 per cent sugar syrup with 0.2 per cent acidity. Boil sugar and water by thorough mixing and strain through a thick cloth. Fill the prepared slices in the cans and pour hot sugar syrup over the slices leaving a head space of 0.5-0.75 cm.

Put the filled cans with their lids in a vessel containing boiling water for exhausting. The level of the water should be maintained at 2.50-3.75 cm below the top of the can. The process is done for 6-7 minutes to remove the air. Remove the cans from exhaust vessel and immediately seal them by a can sealer.

The sealed cans should be placed in a pressure cooker and are steam sterilized at 5 lb. pressure for 20-25 minutes (at sea level). Release the pressure carefully till it comes to zero, open the lid and remove the cans. Cool the cans in running cold water. The cans are removed from water when they possess temperature slightly above to that of the room to avoid rusting in storage. Store the cans in a cool dry place.

2. Dehydrated ripe banana:

For details see page 94.

3. Banana chips:

Select sound raw bananas free from injuries and a little sweet in taste. Wash the fruits and wipe off with a piece of cloth. Peel the fruits with a stainless steel knife and cut into 0.30-0 5 cm thick slices. For avoiding browning of the fruits or slices the same should be kept in water but it is better if immersed in 0.1 per cent citric acid or tartaric acid, 0.05 per cent hydrochloric acid or 0.1 per cent potassium metabisulphite. Remove the slices, wash with cold water, drain properly and spread on wooden slab bottom trays 1/2-1 lb per sq ft of the tray surface. The trays are then kept for sulphuring for one hour in the fumes of sulphur dioxide in a sulphur box.

The treated slices can be dried either in the sun or in a dehydrator. The dehydrator or a home drier proves to be suitable for the purpose. The temperature should be maintained at 140-145°F (60-63°C). Stop the drying when the slices become dry and break into pieces when pressed with hand.

The dried chips can be used like potato chips after frying. The chips can be ground into flour and it is used in many preparations even it can replace a part of the wheat flour.

III. CASHEW-APPLE PRODUCTS

The cashew-apple is the fleshy portion which is attached to the cashew nut. This is a type of by-product of the cashew nut industry. The main growing areas are Travancore, Cochin, Malabar, Goa, North and South Kanara and Ratnagiri districts of the West Coast.

It is bright orange in colour when fully ripe and possesses 50-60 per cent juice with 12-13 per cent sugar and 0.3 per cent acidity. It is markedly astringent in taste and fibrous that is why it is not so popular.

The following products can be prepared from cashew-apple :

1. Cashew-apple candy
2. Cashew-apple jam
3. Cashew-apple juice
4. Cashew-apple syrup

1. Cashew-apple candy:

Select fully ripe, sound and fresh fruits free from blemishes. Wash the fruits thoroughly in running water. Soak the fruits in 2.0 per cent brine and increase the concentration by 2 per cent daily so as to reach 10 per cent in 5 days. After the concentration reaches 10 per cent, potassium metabisulphite at the rate of 0.616 g per kg should be added to the brine, mixed and kept for 2-3 days more. Wash the fruits properly, arrange in a perforated crate and blanch for 5 minutes. Steaming in a pressure cooker at 5 lb. pressure for 5 minutes is done after blanching. Rinse the fruits in cold water for quick cooling and prick it evenly with sharp bamboo needles, wooden pricks or pointed stainless steel fork.

Prepare 30 per cent sugar syrup after adding 0.1 per cent citric acid, strain and pour the hot syrup over the fruits placed in an aluminium, enamelled or stainless steel vessel and submerge the fruits. The fruits should be immersed properly by putting a flat cover and weigh, keep the fruits in this condition for 24 hours. Next day drain the syrup and raise it to 35 per cent. Boil the syrup for 5·7 minutes, strain and pour it back over the fruits. The same process is repeated every day till the concentration reaches 60 per cent. Repeat the process after 48 hours and raise the strength to 70 per cent. At this stage the fruits are left for 5-6 days for complete penetration of sugar. Strain the fruits and dry the product to make a candy. Pack in wide mouthed clean jars and close air-tight. Store in a cool dry place.

2. Cashew-apple jam:

Select and wash the fruits as mentioned above and soak in 2.0 per cent brine. Remove the fruits from brine after 3 days, wash properly to remove salt. Arrange on a perforated crate and steam for 10-15 minutes at 10-15 lb. pressure, according to the condition of the fruit. Remove the blackish portions if any and crush the fruits with a wooden ladle.

Take the equal amount of sugar and 1.0-1.5 g citric acid per lb. or 2.2-3.3 g per kg of the fruit. Add the sugar to the crushed fruits and cook up to a temperature of 221°F at sea level or when product becomes sufficiently thick like a fruit jam described before. Citric acid should be added in the end of the cooking process.

Put the boiling hot jam in dry, clean and previously sterilized jars or cans. Seal immediately and invert to sterilize the lids. A layer of wax can be made over the jam after 2-3 hours of pouring the product in the jars.

3. Cashew-apple juice:

Select fresh fully ripe and sound fruits and wash them thoroughly. Arrange the fruits on a perforated crate and steam in a pressure cooker for 5-10 minutes at 5-10 lb. steam pressure according to the condition of the fruit. Cool the fruits by rinsing with cool and clean water. Extract the juice by pressing through a basket press or worm type juice extractor. Strain the juice through a coarse cloth. Mix 0.045 per cent gelatin to the juice by thorough stirring. Let the juice stand for 15-20 minutes, then strain through a coarse cloth and add 5-6 per cent sugar to it.

The finished product can be preserved by heating or by using sodium benzoate 0.5 g per lb. or 1.10 g per kg. of the finished product.

4. Cashew-apple syrup:

Extract the juice by the above method and add 6.25 per cent lime juice and 0.045 per cent gelatin so as to settle the suspended material. Allow the juice to stand for 15 minutes and strain through a thick cloth. Add sugar to the extract by thorough mixing in the ratio of 2: 3 (sugar: extract) and strain through a thick cloth. This syrup can be diluted to 3-4 times and can be used as a fresh drink.

If it is to be stored boil the juice for a minute, fill hot at 194-203°F (90-95°C) in previously sterilized bottles. Crown cork immediately and then heat in water at 185-194°F (85-90°C) for 30 minutes. Cool the bottles at room temperature. It can also be preserved by adding sodium benzoate at the rate of 1.10 g per kg of the finished product.

IV. CITRUS PRODUCTS

The following are the fruit products which can be prepared from different citrus fruits :

A. **Orange**

1. Orange squash
2. Orange marmlade

B. **Limes and Lemons**

1. Lime juice cordial
2. Lime or lemon barley water
3. Lime or lemon squash
4. Lemon or lime pickle
5. Lime and green chilli pickle

C. **Grape Fruit**

1. Canned grape fruits
2. Grape fruit juice
3. Grape fruit squash

A. ORANGE PRODUCTS

1. **Orange squash:**

For details see page 41.

2. **Orange marmlade:**

For details see page 64.

B. LIME AND LEMON PRODUCTS

1. **Lime juice cordial:**

For details see page 43.

2. **Lime or lemon barley water:**

For details see page 44.

3. **Lime or lemon squash:**

For details see page 39.

4. **Lemon or lime pickle:**

For details see page 96.

5. **Lime and green chilli pickle:**

Select fully matured, sound and juicy limes and good sized green chillies. If the limes are green, they should be kept for a few days for proper ripening. Wash the limes and chillies thoroughly. Cut the limes in halves or quarters according to the size and remove the stalk of the chillies without giving injury to the caps.

For 450 g of lime and chillies take 113 g of well powdered salt (or for one kg 250 g salt) and put in a clean, sterilized wide mouthed jar. Squeeze the juice of the lime, partially on the salt and put the semi-squeezed limes on the same. Give deep longitudinal incisions into the green chillies and add them to the salt and lime mixture. Stir and thoroughly mix the ingredients. If the lime juice is less and does not cover the whole mass, then boiling water with 4-5 per cent citric acid is added to the jars just as to cover the limes and chillies.

The pickle should be kept in the sun for about a week and occasional shaking is essential, so that lime and chillies become soft. The yellow colour of the skin of the lime changes to light brown and the chillies from green to brown. Every care should be exercised to keep off the moisture from the pickle, otherwise it may be spoiled by the attack of moulds.

V. GUAVA PRODUCTS

Guava is one of the important tropical fruits. This is good for stomach and mental disorders. It is rich in vitamin

C and constitutes vitamin A and B as well. The following are the fruit products which can be prepared from this fruit :

1. Canned guava
2. Guava cheese or toffee
3. Guava jelly

1. Canned guava:

For details see page 76.

2. Guava cheese or toffee:

Select sound, firm and ripe fruits of good quality. Wash thorougly and cut into small pieces or slices with a stainless steel knife. Add equal quantity of water and boil till the fruit softens. Separate the pulp through a mosquito net cloth, stainless steel or aluminium sieve and remove the seeds and follow the following recipe :

(i)	Pulp	...	1 kg
(ii)	Sugar	...	1.5 kg
(iii)	Butter or ghee	...	0.125 g
(iv)	Citric acid	...	2.20 g
(v)	Salt	...	1 teaspoonful
(vi)	Red edible colour	...	Sufficient to give an attractive colour to the product.

Mix the ingredients (i-iii) and cook till the mass becomes sufficiently thick. Dissolve the remaining ingredients (iv-vi) in a little of water and add just before finishing. Smear a china plate with butter or ghee and spread the finished product on it in a layer of about 0.65-0.75 cm thickness. Cool the product, allow it to set and then cut into attractive pieces. Wrap in butter paper and store in a clean, dry glass container and seal it airtight.

3. Guava jelly:

For details see page 61.

VI. GRAPE PRODUCTS

The following are the products which can be prepared from grapes :

1. Canned grapes
2. Dehydrated grapes
3. Grape juice
4. Grape wine

1. **Canned grapes:**

For details see page 76.

2. **Dehydrated grapes:**

For details see page 94.

3. **Grape juice:**

Select coloured or white grape berries free from diseases and sound in nature. Coloured varieties are crushed and heated for 10-15 minutes at 140-145°F (60-63°C) for extracting the colour with the juice. The white grapes are crushed and the juice is taken out by means of a basket press or strained through a coarse cloth. The juice is filled in bottles and is kept for 3-4 months at low temperatures so that the cream of tartar may settle properly. The clear juice thus obtained by filteration or syphoning can be preserved by pasteurization or by the addition of sodium benzoate 0.625 g per kg (litre).

4. **Grape wine:**

For details (see page 47.

VII. JACK FRUIT PRODUCTS

The following are the products which can be prepared from jack fruit :—

1. Canned jack fruit pieces
2. Jack fruit jelly
3. Jack fruit nectar
4. Jack fruit pickle

1. Canned jack fruit pieces:

Select ripe fruits with crisp and yellow bulbs possessing a pleasing aroma and flavour. Cut the fruit into large pieces and remove the bulb with the hand after smearing a little mustard oil to avoid the highly sticky latex. Remove the seeds from the bulbs and can whole, halves or quarters.

Prepare syrup of 50° Brix with 0.5-0.75 per cent citric acid. Exhaust at 180-190°F (82-88°C) and the cooking is done for 30 minutes by keeping the cans in boiling water.

2. Jack fruit jelly:

The thick rind and the inner perigones are used for preparing jelly. For other details see page 61.

3. Jack fruit nectar:

Take the bulbs, cut into small pieces. Add water half in quantity of the pieces and heat over a low flame by stirring properly. Mash the softened pieces and prepare a fine pulp by crushing. Rub the pulp through a fine sieve to remove undesirable pieces and follow the following recipe.

Pulp	...	1 kg
Water	...	1.5 ,,
Sugar	...	2.25 ,,
Citric acid	...	0.75 ,,

For preservation of the produce, add potassium metabisulphite at the rate of 0,25 g per lb. or 0.616 g per kg of the finished product.

4. Jack fruit pickle:

Select tender green jack fruit. Peel the outer spiny rind with a stainless steel knife and cut the peeled fruit into 1.25-2.00 cm thick slices. Fill these slices in a glazed or glass jar and cover with 8 per cent brine. The pieces should be retained will immersed in the brine by placing a wooden weight. Increase the strength of the brine daily till it reaches 15 per cent. Allow the slices to soften and remain in this solution for 8-10 days.

(i) For preparing sweet spiced vinegar pickle, follow the following recipe :

Sugar	1.0 kg
Vinegar (8 per cent)	1.33 ml
Water	0.50 ml
Cloves (headless)	0.726 g
Cinnamon (whole)	0.726 g
Coriander seed	0.726 g
Dried ginger (ground)	0.726 g
Mace (broken)	0.726 g
Mustard seed (broken)	0.726 g

Take the spices in a loose muslin and place in a vessel containing water, sugar and vinegar, cook on a low flame for 3-4 hours so that the spices are extracted. If desired, more spices may be added according to the taste. Cool the vinegar extract and remove the cloth bag. Use equal quantity of salt cured slices and spiced vinegar.

(ii) *Plain vinegar pickle*:

In this case only 8 per cent vinegar without sugar and spices is used. In the first instance the vinegar gets diluted and it should be replaced by fresh 8 per cent vinegar. The salt cured pieces look very attractive in the vinegar solution.

(iii) *Sweet oil pickle*

Recipe:

(i)	Brined slices	1 kg
(ii)	Salt	0.062 kg (62 g)
(iii)	Chilli powder	18.5 g
(iv)	Cumin seed	3.1 g
(v)	Cloves (headless)	3.1 g
(vi)	Cinnamon	3.1 g

(vii)	Cardamom major	1.5 g
(viii)	Dried ginger	1.5 g
(ix)	Onion (chopped)	30.1 g
(x)	Mustard seed	3.1 g
(xi)	Gingelly oil	123.0 ml
(xii)	Garlic (chopped)	3.1 g
(xiii)	Vinegar	123.0 ml
(xiv)	Sugar	123.0 ml
(xv)	Oil	Sufficient to cover the pickle

Fry the chopped ginger, onion, garlic and mustard seed in a small quantity of water until they turn brown. Put the brined pieces in a glazed jar and mix the spices well and put in the sun for 3-4 days with occasional stirring. Cover the mouth of the jar, add sugar and vinegar, mix well and put the jar in the sun for 3-4 days more. Fill the pickle in glazed, or earthen glass jars and pour sufficient oil to cover the pickle, which improves the keeping quality of the pickle.

VIII. LITCHI PRODUCTS

1. **Canned Litchi fruits:**
   For details see page 76.
2. **Litchi squash:**
   For details see page 40.

IX. LOQUAT PRODUCTS

1. **Canned loquat:**
   Loquats can be cut into halves and are then canned. For details see page 72.
2. **Loquat jelly:**
   For details see page 61.
3. **Loquat jam:**
   For detail see page 57.

X. MANGO PRODUCTS

A variety of fruit products are prepared from the mango fruits (ripe and unripe both). The following are the different preparations which can be prepared easily and can be preserved for a longer time from this world famous Indian fruit :

1. Dried mango slices
2. Brined mango slices
3. Mango juice (of unripe fruits)
4. Mango chutney
5. Sweet mango chutney
6. Sweet mango pickle
7. Mango pickle in oil.
8. Mango morabba (preserve)
9. Mango candy
10. Green mango squash (Panna)
11. Milangi (a hot weather drink)
12. Mango jelly
13. Mango cheese or toffee
14. Mango squash
15. Mango honey cocktail
16. Mango jam
17. Canned mango slices
18. Canned mango pulp
19. Mango sauce or ketchup
20. Mango leather (ampaper or amawat)

1. **Dried mango slices:**

This is an ancient method of mango preservation.

Select green and sour fruits and peel them after thorough washing. Remove the stone and cut into slices with a stainless steel knife. Spread the slices evenly on a properly washed cloth and dry it in the sun with utmost cleanliness. The dried slices can be prepared very easily but it should be stirred at proper intervals while drying. It is used in the preparation of vegetables along with spices. Chutney is also prepared from these slices.

2. **Brined mango grains** (Amchur)

The prepared and dried slices should be powdered before the setting of rains, otherwise the product is spoiled due to moisture content and it becomes difficult to make the coarse powder (grains).

Dry the slices and break them into grain form in a 'okhal' or 'dheka' (the device used for hulling paddy). The proportion of green mangoes and the prepared amchur is about 6: 1. If the slices are dried in a dehydrator, then the finished product is better in colour, flavour and keeping quality when compared to that dried in the sun. When the 'amchur' is ready, it can be packed in glass containers and paper or plastic bags. Plastic bags are better as it retains the product in a good form for a longer time.

3. **Mngo juice from unripe fruits:**

Take green mango fruits, wash properly, peel it and cut into small pieces. Crush the pieces and strain through a thick cloth to extract the juice. This juice can be retained for one week in this condition. If it is to be stored for a longer time the juice should be strained properly and it can be preserved by adding 0.1% sodium benzoate. This juice can be used in curries, fish, soup etc., for giving a nice taste.

4. **Mango chutney**:

Take green mangoes, wash, peel and cut into small pieces or slices. Heat the ingredients for 5 minutes. When the slices become soft then add the sugar and the following spices and cook it up to the time it acquires jam-like consistency. Add the vinegar, cool and store.

Recipe:

Mango slices	1 kg
Sugar	0.334 kg
Salt	97.0 g
Ginger (Chopped)	128 g

Garlic (Chopped)	97 g
Red chillies (powdered)	2-3 teaspoons
Vinegar	257 ml

5. **Sweet mango chutney:**
   For details see page 100.
6. **Sweet mango pickle:**
   For details see page 98.
7. **Mango pickle in oil:**
   For details see page 96.
8. **Mango morabba:**
   For details see page 70.
9. **Mango candy:**

Select green mango fruits of uniform size. Remove the stalk with a stainless steel knife and peel it. Put it in water for 3-4 hours. Take out from water, prick it with a stainless steel fork or wooden prick and soak in 2 per cent brine for 24 hours. Make the concentration of the brine to 6 per cent by adding 4 per cent more salt and soak the fruits. Take them out after 3 days and wash 3-4 times with hot water but the water should not be too hot so that the pieces may not be softened. Prepare a 30 per cent sugar syrup and put it on the flame till it boils. Strain the hot sugar syrup on the mango pieces and keep them in this syrup. Go on increasing the concentration of the syrup by 5 per cent on every third day till it reaches 70 per cent. Now take out the pieces from the syrup and put it outside so that the syrupy portion may be drained off. Roll the pieces on well powdered sugar and pack in airtight containers to prevent from moisture. When it is to be used the mango can be cut and the stone should be removed.

10. **Green mango squash:**

Take green mangoes, remove the stalk and roast it in the fire or boil it in water to soften the fruits. Remove the skin and press the pulp through thick cloth so that the thick juice may be extracted. Take the following ingredients and mix them with the extracted thick juice.

Recipe:

Juice	1 kg
Sugar	1.66 kg
Water	1 litre
Black pepper (powdered)	1.5 teaspoon
Roasted cumin seed (powdered)	1.5 ,,
Black salt	3.5 ,,
Mint leaves	4-6 leaves
Potassium metabisulphite	3.3 g

Take one part of the above squash and add 3 parts of water to prepare a tasty drink which prevents from sun stroke and other stomach disorders.

11. Milangi:

Roast the mango fruit in hot ash or fire without flame. Take out the fruits when they become soft, wash and peel. Extract the pulp and strain through a thick cloth and follow the following recipe.

Pulp	1 kg
Sugar	124 g
Water	0.750 litre
Roasted cumin seed	Two teaspoon
Salt	According to taste

12. Mango jelly:

The mango fruits suitable for jelly making should be of at least of 5 weeks and they can be utilized for the purpose until and unless the stone becomes very hard. Therefore, it is a very important point to be considered before selecting mangoes for jelly making, otherwise the jelly fails to set. About 8 weeks old fruits are the best for jelly making.

Peel and cut the fruits into small pieces and heat it in water just covering the fruit pieces for 20-25 minutes on a low flame. Extract the juice and add sugar to the juice in the ratio of 3/4 : 1. Heat it up to 221-222°F (105.0° 105.5°C) and follow the other directions as mentioned on page 61.

13. Mango cheese or toffee:

Wash, peel and cut the fruits into small pieces. Take water half in quantity of the fruits and boil for 25-30 minutes. Take the pulp after removing the juice and add 1/2-3/4th sugar according to the quantity of pulp and heat this mixture up to 222°F. Add 1 teaspoonful butter per lb. or 2¼ teaspoon per kg of the pulp when big bubbling with big froth starts and heat the mixture up to 228-230°F or till the mixture becomes quite thick in conssitency and leaves the pan. Smear a china plate with butter or ghee and spread the product on it and put it for setting. Next day cut it into attractive pieces and warp in butter paper. Store in clean dry containers.

14. Mango squash:

For details see page 40.

15. Mango honey cocktail:

Take ripe fruits, wash and extract the pulp and follow the following recipe :

Pulp	1 kg
Honey	62.0 g
Dried fruits and raisins	124.0 g
Rose water	9.0 ml

Add the rose water, honey and dried fruits to the pulp and mix thoroughly. At the time of serving ice can be added to it for refreshing effect.

16. Mango jam:

Take fully ripe fibreless mangoes. If the fruits are hard, they can be softened by heating for sometime with a little water. Strain the pulp through a stainless steel or aluminium sieve and take pulp and sugar in the proportion of 1: 3/4.

Add the sugar and heat it up to 222°F (105.5°C) or the mixture gives the sheeting test. While cooking the ingredients should be stirred properly. If 0 5 g salt is added to 1 kg jam, it improves the taste of the jam. If the fruits are less acidic (sour) then citric acid can be added at the rate of 2.5-5.0 g per kg of the fruit pulp.

17. Canned mango slices:

Dashehari, Safeda Lucknow, Langra, Benishan Alphonso and Neelum are the best varieties for canning in the form of slices. Gaurject is also canned in Eastern U.P. due to its sweetness and nice flavour.

Select ripe and hard mangoes, wash, peel and cut into good looking slices of the desired thickness with a stainless steel knife. Even a trace of skin with the slices should not be allowed, otherwise they turn black. The slices should be kept in 2 per cent brine which checks the browning and breaking. Before packing the slices should be washed with cool and clean water. In one pound butter can (lacquered or unlacquered) only 325 g of slices should be packed. Prepare a 35-40 per cent sugar syrup and after the first boiling of the syrup add 5-10 per cent citric or tartaric acid and mix it properly and strain the syrup through a thick cloth. Pour the hot syrup in the cans leaving 1.25-2 cm at the top. In one lb. butter can 1/2 lb. (approx. 226 ml) of syrup should be added. Place the cans in boiling water (only 3/4th portion of the can should be immersed) and heat at 170-180°F for 5-6 minutes. Remove the cans and seal immediately. Sterilize the sealed cans at 212°F (101°C) for 20-25 minutes, cool immediately in cold water and store in a cool dry place. If the slices have been packed in a bottle, then the pan should be removed from the flame instead of immersing it in water. (Also see canning of fruits).

18. Canned mango pulp:

Select sweet fibreless mangoes and extract the pulp cautiously with cleanliness. Fill it in the cans leaving a head space of 1.25-2.0 cm. Pulp is more heavier than the juice. That is why the contents can be heated in boiling water at 200°F for 15-20 minutes by proper stirring. The cans are sealed and then sterilized for 30 minutes at 212°F. Cool the cans and store in a cool dry place.

19. Mango sauce or ketchup:

Wash the fruits thoroughly, peel and remove the stone. Cut the fruits in small pieces with a stainless steel knife. Take water half in quantity of the fruits and cook it for 30 minutes. Strain the pulp through a mosquito net, aluminium or stainless steel sieve and follow the following recipe :

Pulp	1 kg
Onions (chopped)	33 g
Black pepper	22-33 g
Red chillies (powdered)	0.81 g
Ginger (chopped)	16.5 g
Cumin seed	8.0 g
Cloves (headless)	1.10 g
Cinnamon (powdered)	8.0 g
Cardamom (major)	8.0 g
Mace	2.20 g
Salt (powdered)	8.0 g
Sugar	128.0 g
Vinegar	27-50 ml

Take the spices in a small loose muslin bag and put in the boiling pulp. The small loose bag system is always better as it improves the look and taste of the sauce when compared to the directly added method. When the pulp becomes sufficiently thick, squeeze the small bag and extract the juice an dthe flavour of the spices. Add the salt at this stage, but the sugar should be added in three instalments giving a gap of about 2-3 minutes. In the end, add the clear vinegar and boil the ingredients for a few minutes to attain a thick consistency. To the finished product add 0.25 per cent sodium benzoate and preserve in clean and previously sterilized bottles.

20. **Mango leather:**

It is also known as mango slap, ampaper, amawat. Take well ripened juicy mangoes, wash and extract the juice and pulp cautiously. Strain the pulp and juice through a mosquito net or an aluminium or stainless steel sieve for uniformity. Add sodium metabisulphite 0.62 g per kg so that the product may be prevented from decay or attack of insects etc., at the time of drying. Take nickel plated or stainless steel tray or pan and smear it with mustard oil, Til oil, ghee or butter, so that the mango leather may be taken out easily. In the pan or tray spread the mango pulp in an even and thin layer. After the first layer dries spread the second layer and repeat the process until and unless the product becomes 1-1.25 cm in thickness. When the mango leather is ready, cut into good looking pieces, warp in butter or waxed paper and store in an airtight container.

XI. PAPAYA PRODUCTS

1. **Canned papaya slices:**

For details see page 76.

2. **Papaya chutney:**

For details see Sweet Mango chutney, page 100.

XII. PINEAPPLE PRODUCTS

1. **Pineapple juice:**

For details see page 38.

2. **Canned pineapple slices:**

For details see page 76.

3. **Pineapple jam:**

For details see page 57.

4. **Pineapple squash:**

Extract the juice and follow the following recipe:

	Low sugar content 45% Brix, 1.5% acidity	High sugar content 65% Brix, 2% acidity
Pineapple juice	1.0 kg	1.0 kg
Sugar	1.662 kg	2.445 kg
Citric acid	0.055 kg	0.075 kg
Water	1.255 kg	0.447 kg
Pineapple flavour	0.025 kg	0.033 kg
Edible yellow colour—Sufficient to give pleasing colour		
Preservative (Pot. metabisulphite)	0.25 g	0.25 g

(Also see page 42).

5. **Pineapple preserve:**

Prepare the fruits as for canning. Prick both the sides uniformly with a stainless steel fork or wooden prick. Place in 2 per cent brine for 24 hours. Raise the strength of brine by 2 per cent every day till it reaches 8 per cent. Retain the slices in brine till they are slightly fermented, which softens the slices. Wash the slices properly and place in a syurp of 30° Brix containing 0.1 per cent citric or tartaric acid and boil for 10 minutes. Raise the strength of the syrup by adding sugar by 5° Brix daily until the concentration reaches 70° Brix. Let the slices stand for 10 days in this syrup. Now it is ready to be used as preserve. The fruit slices can be candied by increasing the concentration to 75° and the slices are kept for next 10 days, removed, drained and rolled on finely powdered sugar.

XIII. SAPOTA PRODUCTS

1. Sapota jam:

Select fully ripe and sound fruits with sweet and pleasant aroma and flavour. Wash the fruits thoroughly, remove the outer skin, cut into pieces and remove the seed and other fibrous threads and follow the following recipe :

Pulp	1 kg
Sugar	0.75 kg
Water	125 ml
Citric acid	31.0 g

Mix the above ingredients thoroughly and leave the sediment for 30 minutes to absorb sugar. Cook the mixture, first on a medium fire and stir occasionally. Crush the cooked mass till the temperature reaches 222°F (105.5°C) or the jam acquires a thick consistency and leave the jam.

For filling, cooling, storage etc. (See page 58.)

2. Sapota squash:

For details see page 42.

XIV. TOMATO PRODUCTS

Considering the health point of view, tomato possesses a very important place in vegetables. It is very rich in minerals and vitamins A and C. It is available in plenty in its season at a very cheap rate. So at the proper time the fruits should be preserved for future consumption. The following are some of the products which can be prepared from tomato :

1. Tomato juice
2. Tomato Jam
3. Canned tomatoes
4. Tomato cocktail
5. Tomato sauce
6. Tomato soup
7. Tomato chutney
8. Tomato paste

1. Tomato juice:

For details see page 37.

2. Tomato jam:

Select ripe and red tomatoes and wash properly. Dip it for 2-3 minutes in boiling water by keeping in loose muslin bag. After removing from the boiling water, immerse them immediately in cold water. The skin will crack and it will be easier to remove it. Take the peeled tomatoes in a stainless steel or aluminium pan, crush it with a wooden laddle and heat it for 30-45 minutes, so that it may attain a thick consistency. Remove the pulp from fire, strain through a mosquito net cloth, stainless steel or aluminium sieve and add sugar in proportion of 1: 3/4 (pulp : sugar), start the cooking again and heat the mixture up to 221°F. If the flame is good, then the jam can be prepared in about 1-1¼ hour. When the temperature cannot be taken due to the absence of thermometer, the end point can be observed when the mixture becomes of a thick consistency and on shaking the pan, the jam leaves the pan and its surface looks clearly. For this type of observation one should be very experienced.

Remove the jam from the flame, pour it in sterilized, clean jam bottles and store in a cool dry place.

3. Canned tomatoes:

Peel the tomatoes as mentioned above and pack it in the cans leaving a head space of 0.75-1.25 cm, so that tomatoes may not be spoiled. In an A 2½ size can, add one teaspoonful of salt and teaspoonful of sugar and fill the juice which comes out while peeling. Exhaust the can at 200°F for 10 minutes and seal the cans immediately, keep the cans in boiling water and sterilize it for 30-45 minutes. Pressure processing is not essential as the tomatoes are acidic.

4. Tomato cocktail:

This is a modern drink. Extract the juice as mentioned for No. 1 (Tomato juice—page 37) and follow the following recipe :

(i)	Tomato juice	1 kg
(ii)	Lime juice	13 ml
(iii)	Vinegar (10% acitic acid)	44 ml
(iv)	Sugar	6.6 g
(v)	Salt	8.8 g
(vi)	Cloves whole (headless)	0.33 g
(vii)	Black pepper	0.22 g
(viii)	Cinnamon	0.22 g
(ix)	Cardamom (major)	0.22 g
(x)	Cumin seed	0.22 g
(xi)	Red chillies (finely powdered)	0.055 g
(xii)	Ginger (chopped)	0.33 g

Take the spices (vi-xii) in a small loose muslin bag and put it in the juice and heat it for about 20 minutes in a covered vessel, open the pan and add vinegar, lime juice, salt and sugar (ii-iv), mix the ingredients, heat it at 180-190°F (82-88°C) and fill into previously sterilized clean bottles. Seal and sterilize the bottles by immersing in boiling water for 30 minutes at 212°F (100°C). Cool and store in a cool dry place.

5. **Tomato sauce or ketchup:**

Extract the tomato juice as mentioned for No. 1. Here the juice should be extracted with the pulp and the following recipe is followed. The spices should be of first grade quality as both the colour and flavour of the sauce are dependent on the quality of spices.

(i)	Tomato juice	1 kg
(ii)	Garlic (chopped)	1.10 g
(iii)	Onion (chopped)	16.50 g
(iv)	Red chillies (powdered)	0.55 g
(v)	Cardamom major	0.22 g
(vi)	Cinnamon	0.22 g

(vii)	Black pepper	0.22 g
(viii)	Mace (not ground)	0.22 g
(ix)	Cloves whole (headless)	0.55 g
(x)	Cumin seed	0.22 g
(xi)	Vinegar	46.00 g
(xii)	Sugar	38.50 g
(xiii)	Salt	13.20 g

Take the above spices (ii-x), ground coarsely and put in a small loose muslin bag. Put the bag and one-third sugar (for improving the tomato colour) in the juice and heat the mass up to the time it becomes one-third or slightly less than the original volume taken, add the remaining two-third sugar, remove the bag and squeeze it to extract the flavour and aroma of spices. Heat the ingredients for some more time to maintain the one-third volume of the original, add vinegar and salt and heat for five minutes. Remove the vessel from the flame and add sodium benzoate 0.025% or at the rate of 0.286 g per kg of the finished product, seal airtight and pasteurize in boiling water for 20-30 minutes as a safety major to maintain the product in normal condition for 3-4 weeks during active use.

6. **Tomato soup:**

Extract the tomato juice as mentioned for No. 1 (page 37) and follow the follow recipe:

(i)	Tomato juice	1 kg
(ii)	Onion (chopped)	77.0 g
(iii)	Clove whole (headless)	0.22 g
(iv)	White pepper (ground)	0.22 g
(v)	Red chillies (ground)	0.22 g
(vi)	Ginger (ground)	0.176 g
(vii)	Cinnamon (ground)	0.176 g
(viii)	Cumin seed	0.066 g
(ix)	Cardamom major	0.066 g

(x)	Black pepper	0.066 g
(xi)	Arrowroot starch	0.360 g
(xii)	Butter	8.80 g
(xiii)	Sugar	21.00 g
(xiv)	Common salt (powdered)	20.90 g

Prepare a thin paste of sodium bicarbonate in water and add to the juice to neutralize about 1/6th acidity of the juice. Keep 9/10th of the juice thus prepared for boiling. Take the spices (ii-v) in a small loose muslin bag as in the case of tomato sauce or cocktail. To the remaining 1/10th juice add the butter and arrowroot by rubbing and mix it properly to form a paste. Add this mixture to the boiling juice when it becomes thicker in consistency. Boil the ingredients thoroughly and cautiously by proper stirring so as the mixture may not form a clot or get charred. In the end of the process, add the sugar and salt, mix and boil for next 2 minutes to dissolve them. Fill the soup in cans or bottles. Sterilize the bottles for about 30 minutes at 240°F, and at the same temperature A 2 cans for 45 minutes and 1 lb milk or jam size cans for 40 minutes. Cool quickly and store in a cool dry place.

7. Tomato chutney:

Select ripe but firm tomatoes and cut into small pieces. Remove the seeds and take the ingredients in the proportion given below:

Recipe:

(i)	Tomatoes pieces	1.0 kg
(ii)	Apple slices	0.20 kg
(iii)	Sugar	0.80 kg
(iv)	Salt	0.64 kg
(v)	Cinnamon	2.64 kg
(vi)	Cloves (headless)	0.88 kg

(vii)	Red chillies	0.88 kg
(viii)	Ginger (chopped)	11.00 kg
(ix)	Mace	0.44 kg
(x)	Onions (chopped)	0.50 kg
(xi)	Vinegar	200 ml

Take the tomato pieces, apple slices and the powdered or chopped spices (v-x) in a stainless steel or aluminium pot, mix the ingredients and put over a low flame. Cook the mixture until and unless it attains a thick consistency. Add the vinegar and cook for another 5 minutes. Pack the chutney thus prepared in wide mouthed bottles and seal airtight.

8. **Tomato paste:**

'Tomato paste' is a concentrated tomato juice or pulp which is without seeds and possess not less than 25% of solids. If it is concentrated to 33 per cent or more, it is known as 'concentrated tomato paste'. Common salt and basil (Tulsi) leaves can be added to it. Some acidity of the paste can be neutralized by adding sodium bicarbonate as in the case of tomato soup. The tomato juice is concentrated in vacuum pans as it can only be concentrated up to 14-15 per cent in open pans. However, the initial concentration is done in open pans and finished in vacuum pans.

CHAPTER 13

FRUIT BY-PRODUCTS

The production of waste products cannot be avoided while canning fruits and the preparation of jams, jellies, marmlades, squashes, juices, dried products etc. These products are wasted if not utilized properly. Hence, it proves to be a matter of great importance for a man engaged in this industry. The following products can be prepared from waste materials produced while preparing fancy products from different fruits :

1. Apple:

The pomace obtained after extraction can be used for preparing pectin.

2. Apricot:

Kernels of white apricots are sweet and can be added to the jam after removing seed coat. It improves the colour and appearance. Oil can also be extracted from the kernels, after refining it is just like almond oil, which can be used in pharmaceutical and cosmetic preparations. The oil cake is very rich in protein and can be used as cattle feed.

3. Citrus fruits:

Peels are the most important waste materials. Peels can be used for candying, extraction of essential oil. Citric acid can also be prepared. Orange residues can be used for vinegar preparations.

4. Grape:

The stem of grapes left after preparation of juice and wines is used for preparing cream of tartar. Oil can also be extracted from the seeds. Oil cake can be used as a cattle feed.

5. **Guava:**

The most important product prepared from guava wastes is guava cheese. It is prepared from the pulp left after extracting the juice while jelly making. It is just like the Indian preparation 'halwa'.

For details see page 59.

6. **Jack-fruit:**

The thick rind and inner perigons yield a high class jelly. Pectin can also be extracted from it. Seeds can be taken after roasting and they can also be ground into flour.

7. **Mango:**

Peels can be fermented into vinegar. Kernels taken out from stones can be dried, powdered and used in place of flour, chocolates and cattle feed.

8. **Passion fruit:**

Pectin can be prepared from rind and oil from seeds.

9. **Peach:**

As for apricot.

10. **Pear:**

Peels and cores can be dried and used as an animal feed or can be fermented into perry or vinegar.

11. **Pineapple:**

Refined juice extracted from the shells, trimmings and other waste materials can be used while canning pineapples. Citric acid can also be prepared from this juice. Alcohol can also be prepared by fermenting it. The cores can be used for preparing candy or taken out juice. Press cake after taking out the juice is used as cattle feed.

12. **Tomato:**

The seeds can be used for extracting an edible oil. The trimmings can be used for preparing juice or sauce.

CHAPTER 14

NAMES OF SPICES COMMONLY USED AND SOME IMPORTANT DATA

English name	Vernacular name
Aniseed	Saunf
Asafoetida	Heing
Black pepper	Kali mirch
Cardamom major	Bari ilaichi
Cardamom minor	Choti ilaichi
Cassia leaves	Tej-pat
Cinnamon	Dalchini
Clove	Lawang
Coriander	Dhania
Cumin seed	Zeera
Dried dates	Chohara
Dried ginger	Sonth
Fennel	Saunf
Fenugreek	Methi
Garlic	Lahsun
Gingelly oil	
Ginger	Adrak
Mace	Zavitri
Mustard	Sarson
Nigella	Kalaunji
Nutmeg	Jaiphal
Onion	Pyaz
Raisins	Kishmis, Munakka
Rape	Raie
Red chillies	Lal mirch
Tamaric	Imli
Turmarind	Haldi

Some important data

Area

1 sq inch=6 451 sq cm
1 acre=4840 sq yd
=43560 sq ft

Length

1 inch=2.54 cm
1 ft.=0.305 metre

Volume (capacity)

1 cubic inch=16.39 cc
1 gallon=4.5435 litre
1 quart=1.1359 ,,

Weight

1 sr=16 ch
=2..057 lb
=0.933 kg
=933.088 gm
1 lb=16 oz
=0.453 kg
=453 590 gm
=7000 grain
=0.486 sr
1 kg=1000 gm
=1.070 sr
=2.204 lb
1 ch=5 tola
=58.318 gm
=2.057 oz

1 oz=28.35 gm
=437.5 grain
1 tola=11.662 gm
=12 masha
=96 ratti
1 g=15.432 grain
=0.086 tola
=0.001 kg
1 masha =0.9718 gm
1 ratti =0.1214 ,,
=0.0648 ,,
1 grain

Conversion of temperature:

$$\frac{F-32}{9} = \frac{C}{5}$$

SOME USEFUL NOTES

1. Preservatives to be used should be purchased from a reliable chemist and should be dissolved in a little quantity of water or finished product and then mixed with the rest of the product.

2. The cooking time given for work at sea level should be increased by two minutes per 1000 ft (305 m) rise in altitude.

3. For every 500 ft (152.5 m) rise in altitude the boiling point of water should be decreased by 1°F (0.5°C) and processing time increased as given above (No. 2).

4. To prevent the breakage of glass containers, an insulating material (wooden board or a dry cloth) should be placed underneath at the time of pouring the boiling hot product.

5. The filled bottles should be pasteurized by placing in a vessel having a false bottom (a double or four fold thick cloth placed at the bottom of the pan) and covered with water which is kept boiling for the desired time. Pasteurization done by this method prevents the glass containers from breakage and bumping at the time of process.

6. Cooking utensils, coring and peeling knives, forks, measuring vessels, spoons and sieves must be non-corrodible and should not be of iron or copper in any case. Glass containers made of glass, stainless steel or aluminium are quite suitable. Knives, spoons and sieves should also be of stainless steel or aluminium.

NAMES OF INDIAN FRUITS

Indian Name	English Name	Botanical Name
Aaroo	Peach	*Prunus persica*
Aam	Mango	*Mangifera indica*
Amrood	Guava	*Psidium guajava*
Anar	Pomegranate	*Punica granatum*
Angoor	Grape	*Vitis venifera*
Anjeer	Fig	*Ficus carica*
Annannas	Pineapple	*Ananas comosus*
Aonla	Aonla	*Phyllanthus emblica*
Badam	Almond	*Prunus amygdalus*
Bael	Bael	*Aegle marmelos*
Ber	Jujube	*Zizyphus mauritiana*
Chikoo	Sapota	*Achras sapota*
Jamun	Jambolana	*Syzygium cumini*
Kaith	Wood apple	*Limonia acidissima*
Karaonda	Carrisa	*Carrisa carandas*
Kathal	Jack fruit	*Artocarpus heterophyllus*
Kela	Banana	*Musa* sp.
Litchi	Litchi	*Litchi chinensis*
Loquat	Loquat	*Eriobotryo japonica*
Nashpati	Peat	*Pyrus communis*
Nimbu (kagzi)	Lime	*Citrus aurantifolia*
Nimbu	Lemon	*Citrus limon*
Papeeta	Papaya	*Carica papaya*
Patua (edible)	Roselle	*Hibiscus sabdariffa*
Petha	Petha	*Benincasa cerifera*
Phalsa	Phalsa	*Grewia asiatica*
Seb	Apple	*Malus pumila* or *M. sylvestris*
Shantara	Orange (mandrin)	*Citrus raticulata*

CHAPTER 15

ESSENTIAL APPARATUS AND EQUIPMENTS

S. No.	Name of the apparatus or equipment	Place of availability
1.	Balance with small weights	
2.	Basins (enamelled)	
3.	Basket Press (lab. type)	G. & Co., Bombay, & Gar. Corpn., Delhi.
4.	Brushes (bottle cleaning)	—
5.	Bucket (enamelled)	—
6.	Bucket (Gal. iron)	—
7.	Can and cork opener	—
8.	Cans (sanitary, one lb, A$_2$, A2½) according to requirement.	Metal Box Co. of India, Calcutta.
9.	Can sealer (Dixie type) with spare parts.	
10.	Carboy (glass) cap. 40 lb	Any scientific store
11.	Cooking pans (Aluminium)	
12.	Crown corks	
13.	Crown corking machine	G. & Co., Bombay & Gar. Corp., Delhi
14.	Cups (enamelled)	—
15.	Cylinders (graduated)	—
16.	Funnel (enamelled)	—
17.	Glass jars (screw cap)	—
18.	Gloves (rubber)	—
19.	Hearths (charcoal)	—
20.	Heater (electric)	—
21.	Home drier (cabinet type 3′×2′×3′) with six spare trays.	G. & Co., Bombay & Gar. Corp., Delhi

22.	Hydrometers (brix) — all ranges from 0°-90°	G. & Co., Bymbay & Gar. Corp., Delhi.
23.	Ladle (wooden)	,,
24.	Lime juice squeezers	—
25.	Mix master (Juice extractor)	,, ,,
26.	Ordinary corks	
27.	Plates (enamelled)	—
28.	Pressure cooker (Burpee type)	,, ,,
29.	Screw type juice extractors	,, ,,
30.	Sieves (1 mm. mash)	—
31.	Spirit lamp	—
32.	Stainless steel knives (cutting, peeling, corking, pitting)	—
33.	Stove kerosene, Primus or any other good quality	—
34.	Thermometer (F)	,, ,,
35.	Tumblers (glass)	—
36.	Vacuum gauge	,, ,,

Note: 1. Cans or other sealing equipments can be had from Metal Box Co. of India, Calcutta, or through any of its branches at Bombay, Madras, Mangalore or Delhi.

2. Machinery including knives can be secured from Food Machinery supplies like M/s. Gladwyn & Co., Horny Road, Bombay, or Gardeners Corporation, Connaught Circus, New Delhi.

3. Items of every day use can be purchased from general merchants or hardware firms.

4. Miscellaneous laboratory equipments can be purchased from any scientific store.

TEMPERATURES FOR THE COLD STORAGE OF VARIOUS FRUITS AND VEGETABLES

Fruits	**Deg. Fah.**
Apples	33-36
Bananas	45-50
Berries (fresh)	36-40
Dates, figs, etc.	55
Fruits (canned)	35
,, (dried)	35-40
Grapes	36-38
Lemons	36-40
Mango	40
Nuts	35
Oranges	45-50
Peaches	45-55
Pears	35
Plums	36-40

Vegetables	**Deg. Fah.**
Watermelons	35
Beans (dried)	32-40
Bulbs	32-35
Cabbage	35
Carrot	35
Cucumbers	38-40
Onions	35-40
Peas (dried)	40
Potatoes	36-40
Tomatoes	35

INDEX

Absence of infection 26
Acetic acid 29, fermentation 29
Acid 59
Aerobe 19
Alcoholic fermentation 29, 51
Ams brothers 4
Angelbert 3
Anaerobes 21
Aonla, morabba 67
Appert 1, 2, 3
Apple, cider 47-48, products 103, chutney 101, juice 103, morabba 69
Apricot, canning,
Aspergillus 22
Augustus de Heine 3
Bacillus botulinus 21, thermoaciduraus 21
Bacteria, cylindrical 19, rod like 19, spiral 19, acetic 19, lactobacilli 19, 20, thermophilis 19, 20, spherical 19
Bel, squash 38, morabba 69
Bananas, canning 104, dehydrated ripe 94, 104, chips 104-105
Beans, canning 81
Ber, candy 71
Berry wines 50
Beverages, fruit 31, alcoholic or fermented 31, non-alcoholic or unfermented 31
Black moulds 22
Blanching 91
Blower 13
Blue moulds 22
Bottling, of fruits 78, vegetables 79
Botulinum 21
Buckling 17
Browning of fruits 24, 66
Byssochiamys Fulva 23
Cabbage, canning 82, dehydrated 94
Can 3, hole and cap 3, filter hole 4, corrosion of 16, open type 4, Sanitary 4, Blackening 5
Candy, ginger 81, Petha 82. Ber 82
Canning of fruits 72, Apple 76, Apricot 76, grapes 76, grape fruit 75, guava 76, litchi 76, mango 76, Papaya 76, Pineapple 77, plums 77, strawberries 77, tomato 77
Canning of vegetables 79-82, Beans 82, beets 82, cabbage 82, carrots 82, cauliflower 82, okra (Bhindi) 83, peas 83, potatoes 83, pumpkin 83, spinach and other greens 83, sweet potatoes 83, turnips 83, curried vegetables 83
Carrot, morabba 69
Cashew apple candy 106, jam 106, juice 107, syrup 107
Cauliflower, canning 82
Champagne 50
Chemical and physical spoilage 12
Chemical preservative 34, potassium metabisulphite 36, sodium metabisulphite 36, sodium benzoate 36, mixing 36
Chilling 91
Chutneys 100, sweet mango, 100, apple 101
Cider 48, vinegar of 51
Citrus products 108

Clarification 33
Cloudy or foggy jelly 61
Clostridium pasteurianum 21
Cobley 5
Coccus 19
Coccobacillus 19
Cordials 43, of lime juice 43
Corrosion of the can 12, 16
Curried vegetables, canning 83
Damage 15
Dates 94
Defects in can 12
Dehydration 90, 93, advantages 93, apple 94, Bananas 94, Dates 94, figs 94, grapes 94, cabbage 94, carrots 94, onion 95, peas 95, potatoes 95, tomato 95
Discolouration 15, of canned products 15
Donkin 3
Drying 90, 92
Dry wines 47
Enzymes 24
Equipments, used in extracting fruits juice 32, for canning and bottling of fruits 72, for canning and bottling vegetables 79
Exausting 75, 81
Exclusion of air 27, moisture 26
Facultative, anaerobe 19, thermophiles 20
Farrow 5
Fastier 3
Faulty retort operation 14
Fermentation 31, alcoholic 31, 51, acetic 29, lactic 30, vinegar 53
Fermented fruit beverages 47
Figs, dehydrated 94
Flat sour 12
Flavoured drinks 44
Flipper 13
Foreign flavours 15
Fruit beverages 31, alcoholic 31, non-alcoholic 31
Fruit juices 37, preparation 37
Fruits, products prepared from 103
Fruit syrups, preparation 42
Furrow 5
General considerations in establishing a commercial fruit and vegetable cannery 83
Ginger, (preserve) morabba & candy 69
Glass containers 73
Golden shreds 63
Grading of fruits 72, Fancy 73, standard 73, pie 73
Grapes, products 111, canned 76, dehydrated 94, 111, juice 111, wine 47
Grape fruit, canning of 76, different products of 108
Grape wine, preparation 47
Green 5
Grey moulds 25
Guava, products of 109, Canned 76, cheese or toffee 110, jelly 61, 110
Hall 3
Hard swell 13
History of food preservation and canning 1, sanitary or open type cans 3
Howe 9
Hydrogen swell 13
Infection due to leakage through seam 12, 17, buckling 12, 17, Leakers 12, Flat sour, 12
Jack fruit products 111, canned. 112,

jelly 61, nectar 112, pickle 112, plain vinegar pickle 113
Jamun squash 39
Jams preparation 57
Jellies making 59, preparation 61, cause of failure 62, cloudy or foggy 62, syneresis or weeping 63
Juices, tomato 37, pineapple 38, pomegranate 38
Lacquers, acid resisting clear 5, sulphur resistant 5, double coated meat 5, phenolic meat 5, for deep drawing 5, correnamal 5
Lactic, bacteria 20, souring 20
Lactobacilli 20
Lactic fermentation 30
Leakage, through seams 17
Leakers 18
Lemon, products 108
Lemon barley water 43
Lime, juice cordial 43, products 108, barley water 44, squash 39, pickle 96, green chilli pickle 109
Litchi, squash 40
Louis pasteur 2, 27
Low temperature 26
Lye peeling 73
Malt vinegar 51
Mangoes, different products prepared from 114-122
Marmalades, preparation 64
Metallic flavour 15
Mesophile 20
Mild antiseptics 27
Microbiological spoilage 16
Morabba 66, Aonla 67, Bel 69, carrot 69, Ginger 70, Mango 70, petha 71
Mould 21, 22, 23, blue 22, black 22, byssochlamys fulva 23
Muscat 50
Mucor 23
Needhdam 1
Nicholas Appert 1
Obligate, anaerobe, thermophile 20
Off flavours 15
Orange products 108
Oranges, wine 50, squash 41
Orleans slow process 51
Overfilling 13
Paillard 4
Panneling 14
Papaya products 76, 100, 122
Parry 4
Pasteur, louis 2, 27
Pasteurization 2, 26, 27
Peaches, canning 76, 77
Peaking 18
Pears, perry of, canning of
Peas, canning of 77
Pectin 63, determination 63
Peltier 4
Permanent preservation 27
Perry 49
Peter durand 3
Petha, morabba (preserve) 71, candy 71
Phalsa, squash 41
Pickles, 96, lime 96, Mango 96, mango pickle in oil 97, Red chilli 99, madar leaf 99
Pierade 84
Peeling, hand 73, heat 73, mechanical 73, lye 73, brine 74
Penicillium 22
Pineapple, juice of 38, squash of 123, jam of 57
Plums, jam of 57, canning of 77
Pomegrante juice 40, syrup 40

Port 50
Potatoes, canning of 83, dehydration of 95
Preprocess, spoilage 16
Preserves of fruits 66-71
Preservation, of spoilage and general principles 25, temporary 26, permanent 27, by sterilization 28, by antiseptics 28, by chemicals 28, by drying 28, by sugar 28, by salt 28, by vinegar 28, by pasteurization 28, fermentation 29
Principles of food preservation 25
Processing 81
Pseudo, yeasts 24
Pumpkin, canning of 83
Raymond Chevalier Appert 2
Retort operation, faulty 14
Rust 14
Scope of fruit and vegetable preservation in India 6
Sherry 50
Sheeting test 61
Shriver 2
Sodium benzoate 36
Soft swell 13
Spallananzani 1
Spinach, canning of 83
Springer 13
Spoilage, preprocess 16, chemical and physical 12, microbiological 12, in preserved foods and its prevention 14, enzymetic 27
Squashes, bel 38, Jamun 39, lemon 39, litchi 40, mango 40, orange 41, phalsa 41, pineapple 42, Sapota 42
Stack burning 15
Standard grade 73
Sterilization 79
Strawberry, canning of 77
Sulphur resistant lacquer 5
Sweet wine 47
Sundrying 90
Swells 12, hydrogen 13, soft 13, hard 13
Synthetic drinks 44
Syrups, pomegranate 40
Syneresis of jelly 63
Temporary preservation 26
Tenderometer 16
Thermophiles 20
Tin cans 3, plate canisters 3, containers 3
Tokay 50
Tomatoes, juice 37, products prepared from 124-129
Toughening effect 16
Turnip, canning of 83, sweet pickle of 98
Under exausting 14
Under processing 17
Undesirable textures 16
Unfermented fruit beverages 32
Vegetable, canning of 83, dehydration of 94-95
Vinegar fermentation 53, preparation by-slow process 51, orleans slow process, 52, quick 'generator' or german process 55, mother 20
Weeping jelly 63
Wines 47
Winslow 2
Yeasts 23, 24, pseudo 24